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STUDIES ON THE POPULATION BIOLOGY OF ORNITHOGALUM UMBELLATUM L. (LILIACEAE) FOR ELABORATION STRATEGY OF THE SPECIES SURVIVE IN TRANSCARPATHIA

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(Received September 6, 1988)

Abstract

On the basis of the complex study of demography of *Ornithogalum umbellatum* L. (Liliaceae) in Transcarpathia (determination of age and space structure, density, phytomass, viability and vitality of the populations) degree of stability of the species against the anthropogenic press and prospects of its survival have been revealed. The studied has been carried out by 28 morphometric features, the results have been processed by the method of the principal components (program from package BMDP). By means of correlation and factor analyses peculiarities of reaction of individuals and populations of *O. umbellatum* to the stress influences have been established. Measures for preserving of the genofond of the species in the investigated area are suggested.

Introduction

The most important condition for organizing the effective protection of rare and disappearing plants is estimation of the degree of threat to their existence, of the reasons of reducing their number, revealing the real state and stability of the local population. The most sensitive indication of the reaction of the population to the outer disturbances, including anthropogenic factors is its structure. It reflects the organization of populations in space and time, conditions their ability to resist different stress factors and determines the prospect of their further development.

In this connection keeping within the bounds of the complex program fo studying ephemeroids, the most threatened group of species of natural flora of Transcarpathia (KRICHFALUSHIY et *al.* 1987), we have studied the demography of the population of *Ornithogalum umbellatum* L. (Liliaceae) in various ecological phytocenotic conditions and recreation load regime. Once widely spread in the lowland near the river Tisa and in foothills of the Carpathians. *O. umbellatum* grows today in only 9 isolated localities as a result of the mighty anthropogenic influence. Progressive destruction of the biotopes occupied by the species, insularization and decrease of their areas cause the necessity of complex ecological and biological research for elaborating scientific grounds of genofond protection (MEZEV-KRICHFALUSHIY 1988). Results of quantitative population analysis of *O. umbellatum* are presented in this paper.

Materials and Methods

The objects of the research were 3 isolated populations of *O. umbellatum*: L. The lowland near the river Tisa — I) the outskirts of the village of Storozhnitsa Uzhgorod district, 116 m above the sea-level (*Festucetum pratensis* association of Molinio-Arrhenatheretea Tx. 1937 class). II. Foothils of the Carpathians — 2) the outskirts of the village of Kholmets of the same district, 250 m above the sea-level (*Querco-Carpinetum* association of Querco-Fagetea Br.-Bl. et Vlieger 1937 class); 3) the outskirts of the village of Onokovtsy of the same district, 180 m above the sealevel (*Luzulo-Quercetum petraeae* association of Quercetea robori petraeae Br.-Bl. et Tx. 1934 class). We have accepted the population volume of the corresponding cenopopulation as a work unit. The studied populations are located along increasing gradient of xerophytization of the habitat, and intensification of recreation loads.

In every population transects were lazed for determination of age and space structure, for density and phytomass control, and representative excerpts of generative plants (25 samples from each group) were also made for morphometric analysis. Age group selection and population classification have been carried out by T. A. Rabotnov (1950) and supplemented by other authors (Smirnova et *al.* 1976). For morphometric analysis 28 statistical, metric and allometric parametres have been studied in every individual (Zlobin, 1984). Obtained figures have been processed using correlation and factor methods (Lakin 1980, Iberla 1980, and others). The factor analysis has been carried out by means of the principal components according to BMDP-4M program (California University, USA). Calculations have been made by means ES—1020 computer in the computer centre of the Uzhgorod University.

Results and discassion

Age structure is one of the most important indications fo the population, which means the distribution of individuals according to the age state. The age spectrum is known to reflect the living state of an individual in the cenosis and the degree of its stability as to the influence of unfavourable factors of the environment and anthropogenic press. Besides it characterizes the definite stage in the development of the population, i.e. its age peculiarities as well as ontogenetic rate in separate individuals.

In earlier studies investigated ontogenesis process and determined age states of individuals of *O. umbellatum,* united into seven age groups (se- seeds, p- plantlets, j- juvenile, im- immature, v- virgin, g- generative plants). Senile individuals were not found out, as generative plants fall out of cenosis structure without developing into the following age condition. It has been found out, that in the process of the development of the individuals of Onokovtsy population, carrying out its self-maintenance by seeds pass the full cycle of ontogenesis (se-g_3 — atrophy) lasting 6—8 years. Plants of Storozhnitsa and Kholmets populations with vegetative means of renewal have incomplete ontoegnesis cycle (j-g_3-atrophy) during 4—5 years.

Age structure analysis of population of Storozhnitsa adn Kholmets shows clearly marked leftsidedness of their spectra, the successive raws of age groups from juvenile to generative ones demonstrating sharp decrease in number (Fig. 1, Table 1). These populations are characterized by full predominance of juvenile and immature individuals (88,81—90,14%) over adult ones (9,86—11,19%). There are few generative individuals, middle-aged ard young ones dominating among them. Senile individuals are absent. Though these populations grow in different associations: forest (Kholmets) and meadow (Storozhnica), yet they are characterized by the same (vegetative) way of maintenance its number. The irregular, in the form of more or less distinctly marked groups, location of plants over the cenosis, surface testifies to the fact too. It is quite possible, that such distintly marked leftsidedness of age spectra is explained not only by ontogenesis pecularities of the given species,

Table 1. *Age structure and density of the populations*

Population	Type of phytocenose	Density of individuals sp/m²	Age group					
			j	im	v	g	j+im	v+g
STOROZHNITSA	*Festucetum pratensis*	268	187	51	18	12	238	30
			69,78	19,03	6,72	4,47	88,81	11,19
KHOLMETS	*Querco-Carpinetum*	264	190	48	16	10	234	30
			71,96	18,18	6,06	3,80	90.14	9,86
ONOKOVTSY	*Luzulo-Quercetum petraeae*	353	241	23	36	53	264	89
			68,27	6,52	10,19	15,02	74,79	25,21

Foot-note: individuals quantity for 1 m² in numerator; percentage of individuals quantity for 1 m² from number of plants of all age group in denominator.

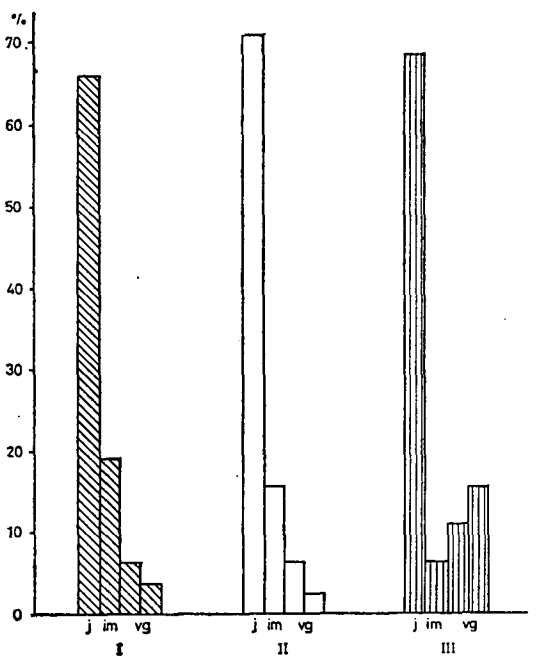

Fig. 1. Ages spectrums of populations I — STOROZHNITSA, II — KHOLMETS, III — ONOKOVTSY j — g — indexes of age states

but largerly by quite sufficient and constantly existing store of diaspores in the soil which gives the advantage in the immediate occupation of reappearing free patches in the cenosis.

Age spectrum of the population of ONOKOVTSY as compared with the previous ones is characterized by two peaks on juvenile and generative individuals; the share of the latter increases by 25,21%. Age composition is marked by sharp decrease of the relative abundance from juvenile to immature individuals and then by increase in number for groups of adult vegetative and generative individuals. This age po-

pulation structure is biologically explicable in that the juvenile group supplemented only by means of seeds, and appearing plantlets often die in winter. Reproduction by seeds of the given population has the periodical character, which causes unstableness and dynamics of its age structure. Distribution of individuals on the cenosis surface is relatively even diffuse.

If we take into account the fact that the juvenile group isn't model for the age structure, we shall see that the population of O. umbellatum greately differ (left- and right-sided). Their structure is correlated with the means of reproduction and maintenance of population number. In totality of characteristic features the populations of STOROZHNITSA and KHOLMETS belong to normal type incomplete young populations and those of ONOKOVTSY — belong to normal type incomplete mature, populations.

Density and store of phytomass are among the most important characteristics of population field of plants. Density of individuals is determined by their number per surface unit.

As it is shown (Table 1), the population density of ONOKOVTSY (353 sperimen/m²) is much higher than that of STOROZHNITSA (268 sp./m²) and KHOLMETS (264 sp./m²), though its total phytomass (417,54 g/m²) is somewhat lower as compared with them (434—444,5 g/m²) (Table 2).

The highest total phytomass of the population of STOROZHNITSA — 444,5 g/m²) (Table 2). It is constituted in almost equal numbers by individuals of pregenerative part of the spectrum (50,64%) and adult plants (49,36%). Reserve of population phytomass of KHOLMETS is a little lower — 434 g/m². It consist of approximately equal shares of phytomass of juvenile and immature (50,97%) individuals on the one hand of virgin and generative ones (49,03%) on the other hand. Total population phytomass of ONOKOVTSY as compared with the population of STOROZHNITSA is lower by 1,06 times, and with the populations KHOLMETS — by 1,04 times. Though the population number of ONOKOVTSY is markedly higher than those two, its phytomass is lower due to the sharp decrease of average phytomass of virgin and generative individuals (Table 2). The average phytomass of juvenile and immature individuals in all populations is almost equal.

Thus as a result of xerophytization of habitats and increase of recreation loads sharp decrease of population of *O. umbellatum* takes place first of all due to lessened adult individuals (both vegetatvie and generative).

Table 2. *Phytomass of individuals and populations*

Population	Age group						Total phytomass of population gm/m²
	j	im	v	g	j+im	v+g	
STOROZHNITSA	0,50	2,58	6,31	8,82	3,08	15,13	444,50
	93,50	131,58	113,58	105,84	225,08	219,42	
KHOLMETS	0,51	2,59	7,63	9,07	3,10	16,70	434,00
	96,90	124,32	122,08	90,70	221,22	212,78	
ONOKOVTSY	0,41	2,48	2,72	3,09	2,89	5,81	417,54
	38,81	57,04	97,92	163,77	155,85	261,69	

Foot-note: weight of individuals in numerator, gm; weight of age group of individuals, gm/m² in denominator.

Viability and Vitality — are peculiarities of populations, displaying in the level of their stability and productivity. The most important indexes are: 1) age srectrum, 2) development rate of individuals, 3) density and 4) living state of adult individuals. The first three characterisrics of *O. umbellatum* population have been already elucidated above. Now we shall consider differentiation of individuals according to their living state which is manifested most fully in the generative period.

As Ju. A. Zlobin (1984) notes, living state of individuals is revealed only when analysing the complex of morphological parameters characteristic for them. To pick out the key morphoparameters from this complex research was carried out with finding out correlation matrixes and factor solutions for all the three populations by the method of principal components. Correlation matrixes of all the populations are fully described by the three factors which totally involve 98,09—99,77 of initial integrity with the contribution of 43,08—57,74% of the first factor. It means that picked out factors give the integral evolution to morphological phenomena.

As to the population of Storozhnitsa and Kholmets the largest contirbution to the first factor is made by such morphological parameters as total phytomass (W) and leaf area (A); as to the population of Onokovtsy — by leaf area (A) and leaf area per phytomass unit (LAR). That is why the first factor may be interpreted as the factor of photosynthetic effort. Such morphological features as flower stalk height, total phytomass (W) and reproductive effort (RE) contribute noticeably to the second factor. On this ground it may be considered as growth factor. Key morphoparametres for population with different means of number maintenance are apparently individual, but all of them belong to the dynamic group (W, A, Lar and others). When ecology conditions plant habitats become worse, their factor matrix structure changes and specific weight of the first factor decreases falls down (Storozhnitsa — 57,74%, Kholmets — 50,55%, Onokovtsy — 43,08%), and the key parameters of morphogenesis also changes. This phenomenon may be explained as general lowering of safety of plants as individuals at their ecological depression (Fig. 2—4).

If the system of correlation bonds of morphological features is considered as manifestation of a vegetable organism integrity stability of correlation bonds appears to be a reaction measure of individuals to different stress influences. To get this characteristics the index of morphological integration of individuals (I) in the form of relation of number of statistically essential bonds (B, P 0,05) in correlation matrix

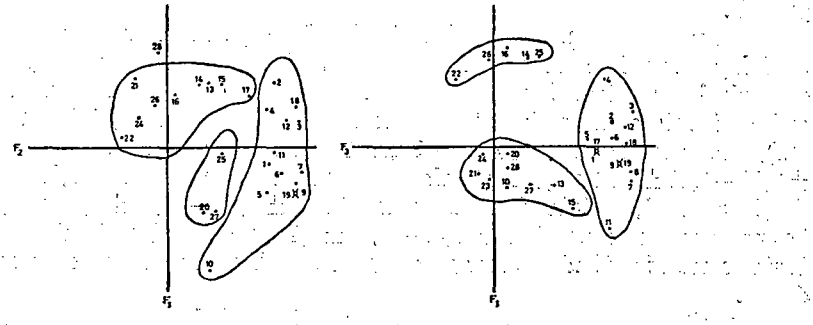

Fig. 2

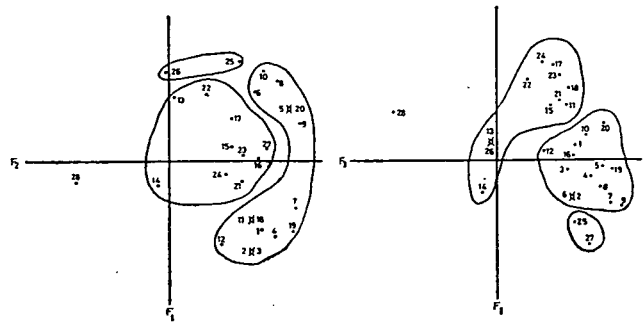

Fig. 3

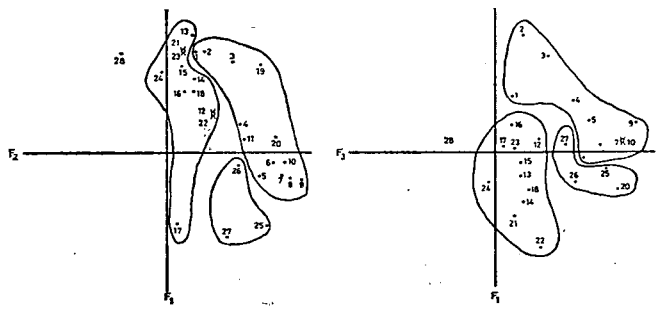

Fig. 4

to their total number (OLSON, MILLER 1958) may be used:

$$I = \frac{B}{(n^2 - n):2} \times 100\ \%,$$

where n is the total number of measured parameters. In finding the total number of bonds diagonal elements were excluded, and the calculation was carried out only in one half of the matrix because of its symmetry. As a result of calculation it was found that for the cenopopulation of STOROZHNICA I=42,00%, KHOLMETS — I= =38,33, ONOKOVTSY — I=35,00, which for certain testifies to the decrease of morphological integrity of individuals of *O. umbellatum* under worse conditions of their growth.

It may become possible of the basis of the parameters to rereveal tendencies of living conditions of ephemeroids by ecology and recreation gradients. When ecological conditions become worse and anthropogenic loads increase, the weight of individuals of O. umbellatum noticeably decrease (fom 9,07±0,38 to 3,09±0,13 gm), the leaf are (55,51±4,07–27,19±2,11 cm²) and the bulb diametre (2,27± ±0,08—1,17±0,04 cm), indication of reproductive effort (68,81±3,30—62,36± ±0,94 gm/gm), height flowers talks (21,03±0,74—16,88±0,55 cm), number of flowers per individual (7,64±0,46—5,36±0,29 specimen) and others decrease too. Living state of individuals along both gradients is seen to become worse without any doubt.

Result of factor analysis may be used for defining population vitality spectra having a number of advantages over revealing the age spectra. The procedure of the

given analysis presented in details in the book by JU. A. ZLOBIN (1984) makes it possible to formalize the determination of structural types of population and to exclude intuitive ways of their estimation. The carried out stuol established that flourishing type of vitality is characteristic of the populations with vegetative maintenance growing in the ecology optimum conditions. Equilibrum type is characteristic of the populations with generative reproduction occuring in phytocenotic optimum conditions. Hence the populations under consideration vary in vitality type and shifts in these vitality spectra reffect conformities to natural laws of inhabitance conditions in different habitats. Quality population trend by recreation gradient is slightly expressed.

On the basis of the analysis of particular fleatures of behaviour of. *O. umbellatum,* according to the ecology cenotic strategy type this species should be reffered to the false explerents (RL). Its overwhelming integral peculiarity is its reactivity characterized by rapid occupation of free areas due to the large store of vegetative diaspores in the soil and high realization of the environmental resources, most distinctly displayed in the populations with vegetative reproduction. Besides, reactivity in combination with great cenotic isolation of clones designates the possibility of long lasting existence of the populations in the loci of climax synusiae.

Thus, the reaction of *O. umbellatum* to worse ecological conditions of habitats and increase of anthropogenic influences is displayed in reduction of density of populations and decrease of their phytomass. Restructuring of morphostructure and general lessening of individuals take place, their viability and morphological integrity decrease. Under the influence of the above factors flourishing populations turn into equilibrium ones, their age and space structure changes.

Our studies showed that *O. umbellatum* is resistant enough to the anthropogenic press, in particular, its populations with vegetative self-maintenance, and reduction of its area is due to destruction of its habitats. By the complex of autophytosoological features the species belongs to class III of the threatened plants (reducing by the International Union of Nature Protection scale) and requires special protectiom measures. With this purpose, practical recomendations have been worked out to preserve the genofond of *O. umbellatum* in Transcarpathia, comprising:

a) creation of two nature memorials in the habitats, exerting intensive anthropogenic loads;

b) organization of constant control over the state of local populations;

c) creation of collection nursery for preservation of intraspecific variety and genetic bank (seeds, meristems) in the botanical garden of the Uzhorod State University;

d) propagation of ecological knowledge among the people.

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A kárpátaljai Ornithogalum umbellatum L. (Liliaceae) populációjának demográfiai vizsgálata a fajfennmaradás érdekében

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Kivonat

Az *Ornithogalum umbellatum L.* (Lililaceae) populációjának komplex vizsgálata (a környezetszennyeződés, az előfordulása, a fitomassza, az életképesség) szerint az antropológiai behatások a faj fennmaradását veszélyeztető határig érkeztek el.

A kutatások 28 morphometriai karakterisztika tanulmányozásán alapulnak.

Az eredmények a főkomponens módszerrel kerülnek feldolgozásra (programterv a BMDP csomagból).

A stressz hatások alatt végzett regressziós-, korrelációs- és tényezős módszerrel kerülnek megismerésre a tanulmányozott populáció jellemvonásai.

A kárpátaljai populáció megvédésére az eredmények eddig igen kedvező úton haladnak.

Популяционно-биологические исследования Ornithogalum Umbellatum L. (Liliaceae) с точки зрения разработки стратегии выживания этого вида в Закарпатии

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Резюме

На основании комплексного исследования динамики популяций *Ornithogalum umbellatum L.* (Liliaceae) в Закарпатии (определение возрастной и пространственной структуры, плотности, фитомассы, жизнеспособности популяций) были выяснены устойчивость видов в отношении антропогенного давления и перспективы их выживания. Было исследовано 28 морфометрических характеристик, результаты обработывали по методу основных компонентов с использованием программ BMDP. Методом корреляционного и факторного анализа были определены особенности стрессовых реакций особей и популяций O. umbellatum. Предложены меры для сохранения генофонда видов исследуемой области.

Izučenje demografije populacije Ornithogalum umbellatum L. (Liliaceae) da bi izradili strategiju preživljenja ovog roda u podgorju Karpata

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Abstrakt

Kompleksno izučenje populacije *Ornithogalum umbellatum* L. (Liliaceae) (struktura okoline, zbijanje, fitomasa, vitalitet) izneo je da antropološki utjecaji doveli do opasnosti za opstanak ove populacije.

Istraživanje osniva se na izučenje 28 morfometrijskih karakteristika. Rezultati su obradjeni na osnovi glavnih komponenata (program iz paketa BMDP). Sa regresivnom-, korelativnom- i faktorskom metodom upoznaju se osobenosti izučene populacije prilikom stres utjecaja.

Rezultati pokazuju najbolji put da bi zaštitili ovu populaciju u podgorju Karpata.

CHANGES IN THE QUALITY OF WATER IN LASKÓ STREAM AND THE STORAGE LAKE BUILT ON IT AT EGERSZALÓK

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Abstrakt

The investigations of Laskó stream were *carried out* in the period of 1984—1987 at Egerszalók and Újlőrincfalva; at the same time a detailed hydrobiological assessment was performed of Egerszalók storage lake set up by damming of Laskó stream.

The effect of the storage lake on the quality of water in Laskó stream has been studied. The water of Egerszalók storage lake is of eutrophic type. The compositional and seasonal changes of the phyto- and zooplankton were followed in consequence of its turning into dead-water. The dominant plankton species belonged to the group of organisms characteristic for dead-waters of high trofity. The richness of species in the storage lake till summer shows an increasing, later — a decreasing tendency. From the beginning of summer till early autumn the dominance of blue-green algae was observed. The shallow water provides favourable conditions for blooming of blue-green algae.

Two characteristic diversity minimal exist — one in winter and the other — in summer. Copepoda prevail in the zooplankton composition the whole year round. In abundance they are followed by Rotatoria and Cladocera. The effect of the storage lake can be detected at Egerszalók, at Újlőrincfalva the unfavourable factors are less perceptible, this is important since Laskó stream is a feed-water of Kisköre storage lake.

Introduction

Laskó stream takes its source in the mountain area between Bükk and Mátra, the spring being of a pronouncedly helokren type. Its watershed area measures 357 km², length — 30 km. It flows through a number of small settlements. Below Egerszalók it reaches the Great Hungarian Plain and at Újlőrincfalva flows into Kisköre storage lake. Its water regime fluctuates from water output of LKQ 200 l/sec till 1% of NQ, 103 m³/sec. The content of suspended matter is higher in the high lands and decreases downstream. The ionic type of the spring is Ca—$MgSO_4$—HCO_3, in the lower reaches — Ca—HCO_3 (ESTÓK, MILINKI and CUCSKAY 1984).

Egerszalók storage lake was built by damming up of Laskó stream in 1981. The distance of the storage lake from the town of Eger is 6 km. Its capacity is 4 180 000 m³, the useful capacity — 3 900 000 m³, surface 121 ha, average depth 3,5 m. It has been built for the purpouses of flood control and irrigation but at present it is of a considerable importance for fishing as well.

The unfavourable changes in water quality are caused by the pollution from the settlements in the watershed area, as well as by the fecal pollution from a goose

farm which has been in operation till 1988 above the storage lake. In addition significant amounts of organic matter are washed out from the surrounding territories. Under the influence of the above factors the lake is strongly eutrophic, which was proven by chemical and biological studies.

The storage lake built by damming up of Laskó stream due to its dead-water nature ensured completely different biotop for the developing "raw or immature" biocenosis (FELFÖLDY 1972).

The increase of the time spent there, as well as the abundance of the organic matter washed out from the surroundings and retained by the storage lake provides a rich nutrition basis for the propagation of phytoplankton. With the spring warming up a significant algal population develop on a rich nutrient media. The species composition of plankton shows seasonal changes (SCHULCZ, MALUEG and SMITH 1976).

The mass appearance of the blue-green algae is not restricted only to autumn, but they are present in high number of individuals already from the beginning of summer (SPODNIEWSKA 1979). According to the strong eutrophic character of the lake two diversity minima are observed. Towards summer the uniformity gradually decreases due to the dominance of blue-green algae (HAJDÚ 1977).

The quantitative and qualitative changes of phytoplankton are followed by changes in the composition of zooplankton as well (KAJAK 1983). Cladocera are found in the lowest numbers, they follow to the least extent the development of trofities. Quantitatively they are significantly surpassed by Rotatoria and Copepoda populations. In case of blue-green algae dominance the number of filtering organisms shows a significant decrease, respectively an overreproduction of smaller species is observed due to their higher tolerance (LAMPERT 1982).

Significant differencies exist between the phyto- and zooplankton composition of Laskó stream and the storage lake (BANCSI, HAMAR et *al.* 1977). The effect of the storage lake on water quality is clearly visible at Egerszalók, after its flowing into Kisköre storage lake it becomes gradually less and less perceptible.

Materials and Methods

For algological and bacteriological investigations water samples of 1 l were collected in sterilized flasks. For zooplankton investigations 20 l water were filtered through a plankton net (mesh 25). The samples were collected 20 cm below the water surface. At the origin and upper reaches of Laskó stream the samples were taken from smaller depths corresponding to the water-level. The bacteriological tests were carried out according to the Methodological Instructions of the Water Hygiene Department of the National Institute of Public Health, the chemical analyses — according to Hungarian Standard 448 and CMEA directives for chemical studies. The identification of plankton organisms was carried out with the help of check-books available in the laboratory.

The studies of Laskó stream were carried out every quarter of a year between 1984 and 1987, and those of the storage lake — monthly in the period of 1986—87. On several occasions samples were taken above the storage lake at Egerbakta to study the effect of the goose farm operating there.

The collected samples were transported to the laboratory in refrigerated state. For qualitative algological studies samples were collected with the help of a plankton net, too, and fixed on the spot in J—JK sodium acetate solution and formalon. In the course of chemical studies the orthophosphate and the total phosphorus content, as well as the parameters of the oxigen and nitrogen metabolism were measured. On the territory of the storage lake five sampling sites were selected taking into consideration the differences in their environmental conditions (Fig. 1).

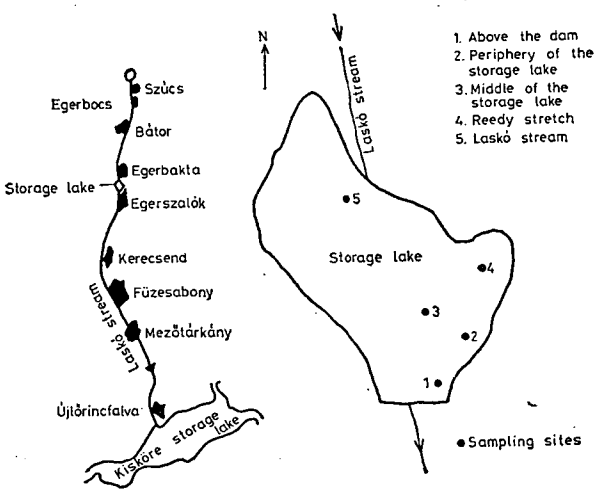

Fig. 1. Sampling sites at Laskó stream and Egerszalók storage lake

Results

In the measurements of the dissolved oxigen and oxigen saturation favourable results were obtained. In summer as a consequence of the process of photosynthesis oxigen oversaturation is observed.

To estimate nutrient content and nutrient supply the characteristics of the nitrogen and phosphorus metabolism were measured. Both values indicate the high nutrient content of the lake. The total phosphorus and nitrate content are significantly higher at the flowing of Laskó stream into the storage lake. Total phosphorus: 2,10 mg/l, nitrate: 16,5 mg/l. The measurements at all other sampling sites along Laskó stream resulted in lower values (total phosphorus: 0,11—0,42 mg/l, nitrate: 0,00—9,4 mg/l).

On the basis of bacteriological studies Laskó stream can be characterized as slightly polluted surface water. In the period of 1984—87 significantly higher values were measured at the goose farm operating in the vicinity of the storage lake.

1987

Above the goose farm		Below the goose farm
Coliform count/1 ml	70	240
Fecal coliform/1 ml	0,2	20
Bacterial count/ml		
20 °C	4000	20 000
37 °C	600	8 000
Fecal streptococcus count/1 ml	1,0	4,0
Clostridium count/1 ml	40	30
Enteral pathogenes	negative	*Salmonella typhi — murium*

At the inflow into Kisköre storage lake at Újlőrincfalva the bacteriological characteristics of water proved to be satisfactory. In the period between 1984 and 1987

enteral pathogene bacteria have not been observed. On one occasion (1984) a high bacterial count was measured (30 000/ml), which was due to the high organic matter content washed in by the flood and present as suspended matter in water. From bacteriological point of view the water below the goose farm was of an objectionable quality. Downstream the pollution gradually decreased and at Újlőrincfalva the effect of the storage lake could not be traced.

The composition of phyto- and zooplankton of samples taken from Laskó stream and the storage lake showed significant differences. For the water of Laskó stream the dominance of diatoms and occasional mass production of green algae, characteristic for fresh water, were observed.

It should be pointed out that the middle reach of the stream can be characterized by the richness of Euglenophyta species. It is due most probably to the effect of Egerszalók storage lake, and organic pollution of Füzesabony.

At Újlőrincfalva as a consequence of the damming effect of Kisköre storage lake the appearance of green algae species in higher numbers, characteristic for dead-waters, was observed (Table 1).

On the basis of Sörensen similarity index the closest correlation was found in case of 2—3 samples. This can be explained by the fact that at Újlőrincfalva due to redamming of Kisköre storage lake a storage lake water character developed (Fig. 2). Along with the decrease in number of fluvial organisms the appearance and dominance of lake algal associations is observed.

In samples taken at different sites of Egerszalók storage lake the organisms listed in the species list were present in different proportions. In the samples collected far from the coastal region dominated typical plankton species. Close similarity in species constitution was observed in samples taken at the dam (sampling site 1.) and at the periphery of the storage lake (sampling site 2) due to similar environmental effects. In the samples taken from the reedy strech (sampling site 4) along with plankton species periphyton algae living in the aquatic vegetation appeared. At the point where Laskó stream flows into the storage lake (sampling site 5) due to the

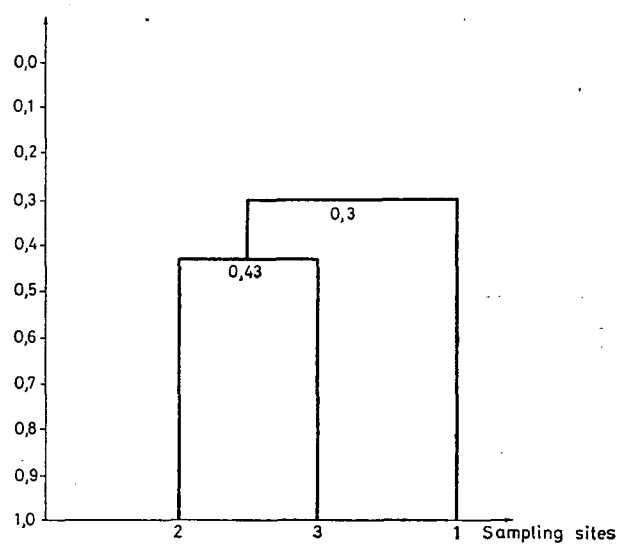

Fig. 2. Sörensen similarity index at different sampling sites

Table 1

	Laskó stream Egerszalók	Újlőrincfalva	Egerszalók storage lake
Cyanophyta			
Aphanizomenon flos-aquae (RALFS)	—	—	+
Anabaena spiroides KLEB.	—	—	+
Microcystis aeruginosa KG.	—	—	+
Oscillatoria animalis AGH.	+	—	—
Oscillatoria limosa AGH.	—	—	+
Oscillatoria tenuis AGH.	—	—	+
Euglenophyta			
Euglena acus EHR.	—	+	+
Euglena gracilis KLEBS.	+	+	+
Euglena granulata LEMN.	—	+	—
Euglena oxyuris SCH.	+	—	+
Euglena proxima DANG.	+	—	+
Euglena viridis EHR.	+	—	+
Phacus acuminatus STOKES			
Phacus caudatus HÜBNER	+	+	+
Phacus curvicauda SWIR.	+	—	—
Phacus orbicularis HÜBNER	+	—	+
Phacus pleuronectes DUJ.	+	—	+
Phacus parvulus KLEBS	+	—	—
Phacus longicauda EHR.	—	—	+
Strombomonas fluviatilis DEFL.	—	+	+
Trachelomonas granulosa PLAVF.	+	—	+
Trachelomonas hispida STEIN	—	—	+
Trachelomonas ovata STEIN	—	—	+
Trachelomonas raciborskii WOLOSZ	—	+	+
Trachelomonas scabra PLAYF	+	—	+
Trachelomonas volvocina EHR.	+	+	+
Chrysophyta			
Amphypleura pellucida KÜTZ	—	—	+
Amphora ovalis KÜTZ	+	+	+
Asterionella formosa HASS.	—	—	+
Achnanthes minutissima KÜTZ	—	+	+
Caloneis amphisbaena CL. BORY	+	+	—
Ceratoneis arcus KÜTZ	—	+	—
Cocconeis placentula EHR.	+	+	+
Cyclotella comta KÜTZ.	—	+	—
Cyclotella menenghiana KÜTZ.	—	—	+
Cyclotella bodanica EULENST.	—	+	+
Cymatopleura solea W. SM.	+	—	—
Cymatopleura elliptica W. SM.	+	—	—
Cymbella caespitosa GRUM.	+	—	—
Cymbella lanceolata W. H.	+	—	—
Cymbella turgida CL.	+	—	—
Cymbella ventricosa KÜTZ.	+	—	+
Diatoma vulgare BORY	+	—	+
Fragilaria capucina DESM.	+	—	—
Fragilaria crotonensis KITT.	+	—	—
Gomphonema angustatum RBH.	+	—	—
Gomphonema capitatum EHR.	+	—	—
Gomphonema olivaceum KÜTZ.	+	—	—
Gyrosigma acuminatum RABH.	+	—	—
Gryosigma attenuatum RABH.	+	—	—

	Laskó stream Egerszalók	Újlőrincfalva	Egerszalók storage lake
Hantzschia ampioxys GRUN	+	—	—
Meridion circulare AG.	+	—	—
Melosira varians AG.	+	—	+
Melosira granulata RALFS.	+	—	—
Navicula cryptocephala KÜTZ.	+	+	—
Navicula hungarica GRUN.	+	+	—
Navicula laterostrata HUST.	+	—	—
Navicula viridula KÜTZ.	+	—	+
Nitzschia apiculata GRUN	+	—	—
Nitzschia palea W. SM.	+	+	—
Nitzschia sigmoidea W. SM.	+	+	—
Nitzschia vermicularis GRUN.	+	—	—
Rhoicosphaenia curvata GRUN	+	—	+
Suriella ovata KÜTZ.	+	—	—
Synedra acus KÜTZ.	+	+	—
Synedra ulna EHR.	+	+	—
Chlorophyta			
Ankistrodesmus falcatus CORDA	—	+	—
Actinastrum hantzschii LAGERH.	—	—	+
Chlamydomonas simplex PASCH	—	—	+
Chlamydomonas planctonica FOTT	—	+	—
Chlorella vulgaris BEI	—	+	—
Coelastrum microporum NAEG.	—	+	+
Crucigenia rectangularis GAY.	—	+	+
Crucigenia tetrapedia G. S. WEST	—	+	+
Elokatothrix lacustris KORS	—	+	—
Eudorina elegans EHR.	—	+	+
Kirchneriella lunaris MŐB	—	—	+
Oocystis lacustris CHOD	—	—	+
Pandorina morum BORY	—	+	—
Pediastrum biradiatum MYEN	—	—	+
Pediastrum duplex MEYEN	—	+	+
Pediastrum simplex LEMM	—	—	+
Pediastrum tetras RALFS	—	+	+
Scenedesmus acuminatus CHOD	—	+	+
Scenedesmus arcautus LEMM	—	+	—
Scenedesmus ecornis CHOD	—	+	+
Scenedesmus spinosus CHOD	—	+	—
Scenedesmus quadricauda BRÉB	+	+	+
Tetraedron minimum HANSG	—	+	+
Tetraedron triangulare KORS	—	—	+
Tetraedron caudatum HANSG	—	+	+
Tetrastrum staurigeniforme SCHROED	—	+	—
Closterium strigosum BRÉB	—	+	—
Cosmarium formulosum HOFFM.	—	—	+
Cosmarium humile NORDST.	—	—	+
Cosmarium laeve RABENH	—	—	+
Radiococcus nimbatus SCHMIDLE	—	—	+
Dictyosphaerium pulchellum WOOD	—	—	+
Pyrrophyta			
Ceratium hirundinella SCHRANK	—	—	+
Peridinium cinctum EHR.	—	—	+

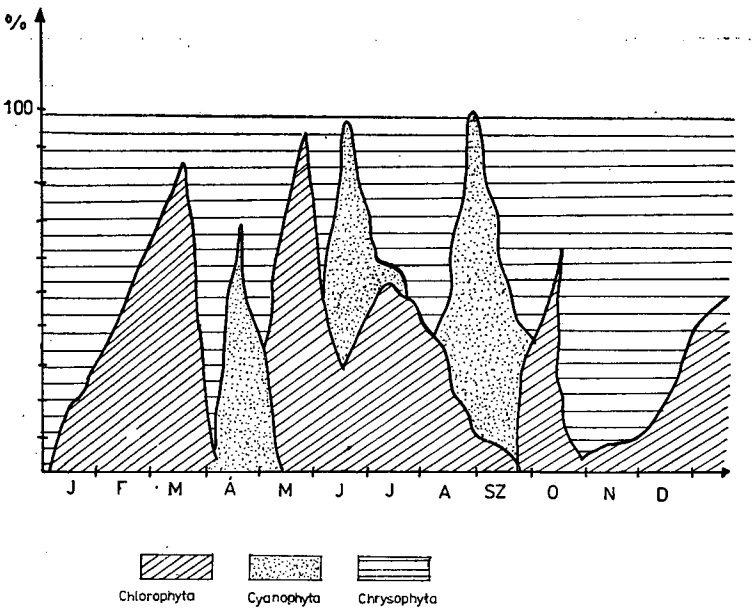

Fig. 3. Percentage distribution of the groups constituting phytoplankton during the year
TCW — Tisza Chemical Works; GÁ — Transloading station at the "Gábor Áron" square; S — Szolnok Sugar Works; P — Szolnok Paper-mill; Mr — Transloading station at the "Mártírok" road; AMP — Szolnok Animal Marketing and Meat Packing Establisment; Tl — Transloading station at Tiszaliget; Vh — Transloading station at the "Vöröshadsereg" road; FPF — Fodder Processing Factory; ΣH — Total household sewage-water; Σ — Total load

redamming effect of the storage lake the interchange of diatoms and green algae dominance was observed.

Seasonal periodicity was observed in the composition of phytoplankton. At the time of spring warming up a spreading of green algae was observed (*Chlorela vulgaris* dominance) which was followed by the appearance of diatoms in high numbers.

In summer Chlorophyta (*Docystis lacustris* dominance) are observed again, which were, however, frequently interrupted by mass production of blue-green algae due to the strongly eutrophic character of the storage lake.

The mass appearance of blue-green algae at different sampling sites led to te displacement of other species. At places in the coastal region they become the only species present. In autumn a new propagation of diatoms and green algae occurs, though in a lower number of species and individuals (Fig. 3). In summer the total algal count shows a tendency for increase. The highest values were measured in summer and autumn (5 000 000—9 000 000 i/l). At the time of blue-green algal bloom the total algal count is in the range of milliards.

The changes in the phytoplankton were followed by changes in zooplankton, too. As expected for deadwaters a rich zooplankton population emerged. In comparison to the storage lake the zooplankton composition at Laskó stream sampling sites was comparatively poor. Here in the first place Rotatoria species represent 50—70% of the plankton. The water in Laskó stream is poor in Cladocera, Copepoda were regularly found in water samples. At Újlőrincfalva due to redamming richer species composition was observed. Among Rotatoria dominated the following spe-

Table 2

	Reservoir				
	Above the dam	Periphery	Middle	Reedy stretch	Laskó stream
Rotatoria					
Brachionus calyciflorus PALLAS	+	+	+	+	+
Brachionus urceolaris D. F. MÜLLER	+	+	+	—	—
Brachionus urceus LIM.	+	+	+	+	—
Brachionus quadridentatus HERMANN	+	+	+	+	+
Colurella colurus EHRENBERG	—	—	—	—	—
Colurella adriatica EHRENBERG	—	—	—	+	—
Cephalodella rotunda DONNER	+	+	+	—	—
Filina logiseta EHRB.	+	+	+	+	—
Gastropus stylifer IMHOF	—	—	—	+	—
Keratella cochlearis GOSSE	+	+	+	+	+
Keratella quadrata MÜLLER	—	—	+	—	—
Lepadella ovalis D. F. MÜLLER	—	—	—	+	—
Notholca acuminata EHR.	—	—	—	+	—
Notholca caudata EHR.	+	+	—	—	—
Phylodina roseola EHR.	+	+	—	+	—
Polyarthra vulgaris CARLIN	+	+	+	+	+
Pompholyx complanata GOSSE	+	+	—	—	—
Pompholyx sulcata HUDS	+	+	+	—	—
Testudinella parva var. *bidentata* TERMETZ	—	—	—	+	—
Testudinella patina HERMANN	—	—	—	+	—
Copepoda					
Acanthocyclops vernalis FISHER	+	+	—	+	—
Cyclops vicinus ULIANINE	—	—	+	—	—
Cryptocyclops bicolor SARS	—	—	—	+	—
Eucyclops macrurus SARS	+	+	—	+	—
Eucyclops serrulatus FISHER	+	+	+	+	+
Eucyclops speratus LILLJEB.	—	+	+	+	—
Macrocyclops albidus JURINE	+	+	—	+	—
Paracyclops fimbriatus Fish.	—	+	—	+	—
Paracyclops poppei REHBERG	—	—	—	+	—
Cladocera					
Bosmina longirostris O. F. MÜLLER	+	+	+	+	+
Bosmina coreogni BAIRD	—	—	—	+	—
Chydorus sphaericus O. F. MÜLLER	+	+	—	+	+
Daphnia cucullata SARS	+	+	+	—	—
Daphnia hyalina SARS	+	+	+	+	—
Daphnia longispina O. F. MÜLLER	+	+	+	—	—
Daphnia magna STRAUS	+	+	—	—	—
Scapholeberis mucronata O. F. MÜLLER	—	—	—	+	—
Scapholeberis mucronata var. *cornuta* O. F. MÜLLER	—	—	—	+	—

cies: *Brachionus, Keratella, Filina, Polyarthra* and *Notholca.* More seldomly *Lepadella* and *Lecane* species were observed.

In Egerszalók storage lake due to abundancy of phytoplankton a significant zooplankton population emerged.

The compositional changes in zooplankton were studied in cases of Rotatoria, Copepoda and Cladocera at different sampling sites of the storage lake (Table 2).

Seasonal changes were observed in the zooplankton composition as well. The spring spreading of green algae is partially preceeded and followed by the increase in the number of Rotatoria (103 i/l). With the advance of Copepoda due to Rotatoria-Copepoda nutrition relationship a significant decrease in the number of wheel animalcules follows.

Cladocera are present in small numbers the whole year round, showing some increase only in autumn. In spring samples species of bigger size *(Daphnia magna)* and in the autumn — species of smaller size *(Bosmina longirostris* and *Chydorus sphaericus)* were found. The propagation of the latter is due to their higher tolerance. Among others, they endure better the infavourable influence of the increased trofity and the accompanying it blue-green algae production. Copepoda can be found in high numbers during the whole year (Fig. 4).

The zooplankton species found are mostly euplanktonic *(Brachionus urceus, Brachionus calyciflorus, Keratella cochlearis, Eucyclops serrulatus),* in the samples taken from the coastal regions species living in the aquatic vegetation were found in small numbers *(Paracyclops fimbriatus, Scapholeberis mucronata, Simocephalus vetulus, Lepadella verifica).* The changes in diversity values were followed in the storage lake at the selected sampling sites in two periods — in april and august. The diversity calculations were carried out with the help of the SHANNON—WEAVER formula which characterizes the diversity of a sample on the basis of distribution of two components:

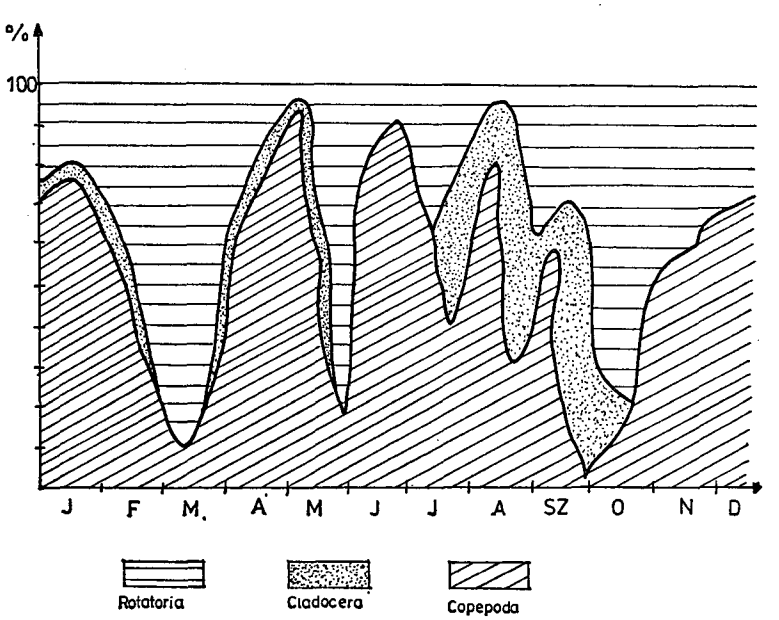

Fig. 4. Percentage distribution of the groups constituting zooplankton during the year

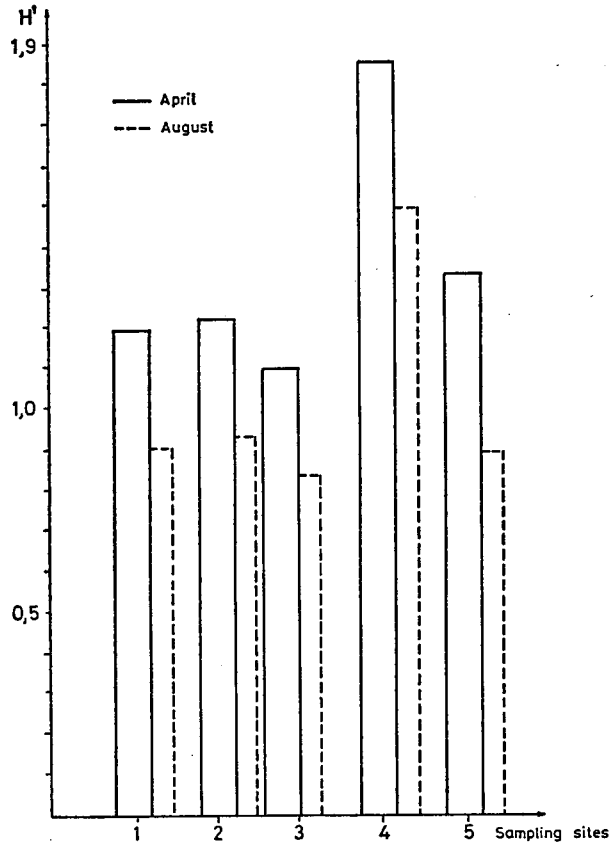

Fig. 5. Values of diversity (H') at different sampling sites

richness of species and frequency of species. The diversity values obtained are represented graphically in Fig. 5.

It can be concluded that the diversity in all habitats decreases in the summer samples, but even so the highest diversity is found in the ready stretches.

To summarize: significant differences were found in the living organisms of Laskó stream and the storage lake set up on it. With the set up of the storage lake a rich phyto- and zooplankton emerged. The high nutrient content leads to establishment of eutrophic, in summer even polyeutrophic conditions. In the phytoplankton in summer and autumn the dominance of blue-green algae is 50—80%. At places all other species were displaced by *Aphanizomenon flos-aquae* and *Microcystis aeruginosa*. Besides the dominance of the blue-green algae, the dominance of green algae of bigger size can be observed.

The composition of phyto- and zooplankton of Laskó stream differs from that of the storage lake. The phytoplankton of Laskó stream is dominated by diatoms, at Újlőrincfalva it shows similarities with the living organisms' associations characteristic for dead-water.

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A Laskó-patak és az ezen létesített Egerszalóki víztározó vízminőségének változása

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Kivonat

Vizsgálatainkat 1984—1987 között a Laskó-patakon Egerszalók és Újlőrincfalvánál végeztük, illetve ugyanezen időszakban részletesebb hidrobiológiai felmérésre került sor a Laskó-patak duzzasztásával létrehozott Egerszalóki tározón.

A tározó hatását vizsgáltuk a Laskó-patak vízminőségének alakulásában. Az Egerszalóki tározó eutróf jellegű víznek minősítehtő. Nyomon követtük az állóvízzé válás következtében megváltozó fito- és zooplankton összetételét és szezonális alakulását. A domináns planktonfajok a magas trofitású állóvizekre jellemző szervezetekből kerültek ki. A fajgazdagság a víztározóban nyárig nő, majd csökkenő tendenciát mutat. Nyár elejétől kora őszig kékalga dominancia figyelhető meg. A kis vízmélység kedvező életteret biztosít a kékalga vízvirágzáshoz.

Két diverzitás minimum jellemző, az egyik télen, a másik nyári időszakban. A zooplankton összetételében a Copepodak uralkodnak egész éven át. Mennyiségben őket követik a Rotatoriak és Cladocerak. A víztározó hatása a vízminőségben Egerszalóknál mutatható ki, Újlőrincfalvánál a kedvezőtlen tényezők kevésbé észlelhetők, ami azért lényeges, mert a Laskó-patak a Kiskörei-tározó egyik tápvize.

Изменение качества воды рулья Лашко и построенного на нем водохранилища у Егерсалок

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Резюме

В период 1984—1987 гг. велись исследования ручья Лашко у Егерсалок и Уйлёринцфалва, а также всестороннее гидробиологическое обследование водохранилища Егерсалок, образовавшегося вследствие запруживания ручья Лашко.

Исследовали влияние водохранилища на качество воды в ручье Лашко. Вода в водохранилище Егерсалок имеет эутрофный характер. Прослеживали сезонные различия и изменения, наступающие в составе фито- и зоопланктона вследствие образования стоячей воды. Доминантные виды планктона принадлежали к группам, характерным для стоячих вод высокой трофичности. Разнообразие видов в водохранилище увеличивается до лета, после чего проявляется тенденция уменьшения. С начала лета до ранней осени наблюдается доминантность сине-зеленых водораслей. Небольшая грубина обеспечивает благоприятные условия для цветения воды сине-зелеными водорослями.

Наблюдали два минимума диверситета — один в зимний, другой — в летний период. В составе зоопланктона в течение всего года преобладают Copepoda. В количественном отношении за ними следуют Rotatoria и Cladocera. Влияние водохранилища сказывается на качестве воды у Егерсалок, у Уйлёринцфалва неблагоприятные факторы менее заметны, что существено с точки зрения качества воды водохранилища Кишкёре, в которое впадает ручей Лашко.

Promene kvaliteta vode u potoku Laško i u rezervoaru Egerszalók

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Abstrakt

Ispitivanje vode potoka Laško vršene kod Egersaloka i Újlőrinc izmedju 1984—87. god. u isto vreme je vršeno detaljno hidrobiološko ispitivanje veštačkog rezervoara za vodu Egerszalók, napravljen na potoku Laško.

Vršeni su ispitivanja indikatornih promena kvaliteta vode rezervoara na potoku Laško.

Rezervoar za vodu Egerszalók ima eutrofičan tip vode. Kao posledica pretvaranja u mrtvu vodu, to pratio i pozicionalna i sezonalna fito- i zooplanktonsko vegetacije.

Dominantni rodovi planktona su karakteristični i za ostale visoko trofične mrtve vode.

Do leta broj rodova planktona se povećava a poslije se to smanjuje.

Od početka leta do kasne jeseni dominancija plavo-zelene alge je bilo utvrdeno.

Plitka voda obezbedjuje povoljne uslove za rast spomenutih algi.

Postoje dva diverzitetna minimum stanja- jedno u leto a drugo u zimi.

Tokom cele godine vrsta Copepoda je dominantni zooplankton.

Abundancija je bila praćena kroz rodova Rotatoria i Cladocera.

INFLUENCE OF THE WASTE-WATER OF SZOLNOK ON THE WATER QUALITY OF THE TISZA RIVER

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Abstrakt

The reach of the river Tisza between the mouth of the river Sajó and the town of Szolnok can be characterized by an improvement of the water quality.

In the middle reach of the Tisza a significant pollution load occurs only at Szolnok.

In the vicinity of Szolnok the Tisza is being loaded significantly by the pollution coming from 5 industrial and 4 residential areas, the waste-waters of which show considerable quantitative and qualitative differences. Both the output of the waste-water released and the load of certain polluting components showed a slight increase in the period between 1977 and 1987. Nearly half of the organic matter is being released into the Tisza by the Szolnok Sugar Works during the 100 days' period of sugar processing. The major part of the detergent, ammonium-ion, fat and oil load is of household origin.

The calculated effect of the pollution loah on the Tisza water quality is worth consideration only in the period of sugar processing (September—December). For this reason the deterioration of the water quality has been studied in details only for these periods. The deterioration of the water quality was clearly visible in comparative studies of the water quality in the reaches above and below Szolnok (Tiszaug) based on measurements of organic matter, dissolved oxygen and phosphate-ion concentrations (minimum, average maximum values, distribution curves).

The actual deterioration of the water quality was less expressed than could be expected from calculations due to the self-purification of the river and did not justify its reassignment to lower quality categories for none of the quality parameters.

Introduction

The influence of the waste-waters of the town of Szolnok on the Tisza has been studied on Ciliata already in 1974 by JÓSA (1974). The investigation of the classical parameters in the Tisza reach between Szolnok and Tápé could not demonstrate unequivocally the joint effect of the sewage-water of Szolnok and the waste-water carried by the river of Zagyva (HAMAR et *al.* 1976). However, the detailed investigation of the Tisza longitudinal stretch in 1979, has clearly shown the effect of the waste-water on the basis of increased Clostridium count of the sediment (HEGEDŰS et *al.* 1981) and growth of the Ciliata population (JÓSA 1981).

The water of the Tisza reaching the territory of Hungary is of a comparatively favourable quality (VÍGH 1983). However, it is unfavourably influenced by the polluting materials carried by the Szamos and Sajó rivers. The middle reach of the river can be characterized by an improvement of the water quality. This stretch receives

the highest pollution load in the vicinity of Szolnok. For this reason, the aim of the present work was to elucidate the level of the pollution load in this region and its influence on the water quality of the Tisza. Only the effect of the so-called macro-components of the sewage-water has been studied, other factors modyifing the quality of water (e.g. increase of the receptive bacterial contamination, etc.) have not been dealt with.

Results

1. Trends in the pollution load

In the vicinity of Szolnok nine sources of significant pollution load of the river Tisza can be distinguished (Fig. 1, WAIJANDT 1987a). Their waste-waters show considerable quantitative and qualitative differences. Among the five industrial sources, four (Paper-mill, Animal Marketing and Meat Packing Establishment, Tisza Chemical Works, Fodder Producing Factory) load the Tisza with nearly equal waste-water output the whole year round, contrary to the Szolnok Sugar Works which releases the waste-water mainly in the period of sugar processing between September and December — appr. 100 days a year (waste-water output: 20 000 m^3/d).

The sewage-water of the housing estates in Szolnok are loaded into the Tisza by four transloading stations: at "Gábor Áron" square, "Mártírok" road, "Vörös-hadsereg" road and Tiszaliget. In the last 11 years the output of the sewage-water reaching the receptable (Q) has hardly increased (Fig. 2). However, the organic matter carried by the sewage water has considerably increased in the investigated period.

The total mineral matter load showed an increasing tendency as well. The anion-active detergent content has been increasing only till 1981. A considerable increase in the oil and fat content has been observed till 1984. The annual number of tests carried out varied between 2 and 12 depending on the level of pollution).

From the point of view of pollution reduction by purification, it is important to know the distribution of different polluting components among the sources of

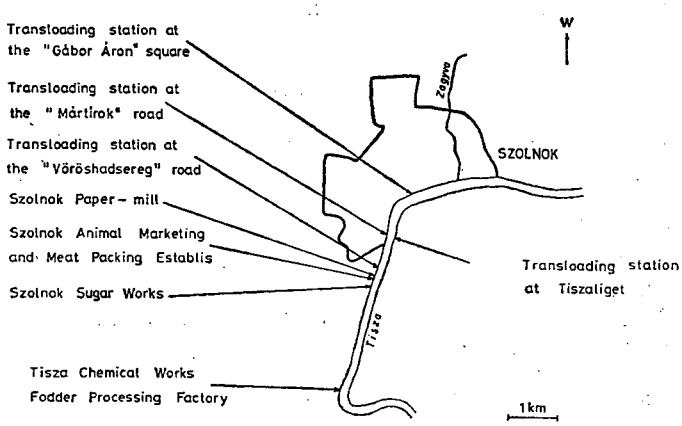

Fig. 1. Sources of waste-water at Szolnok

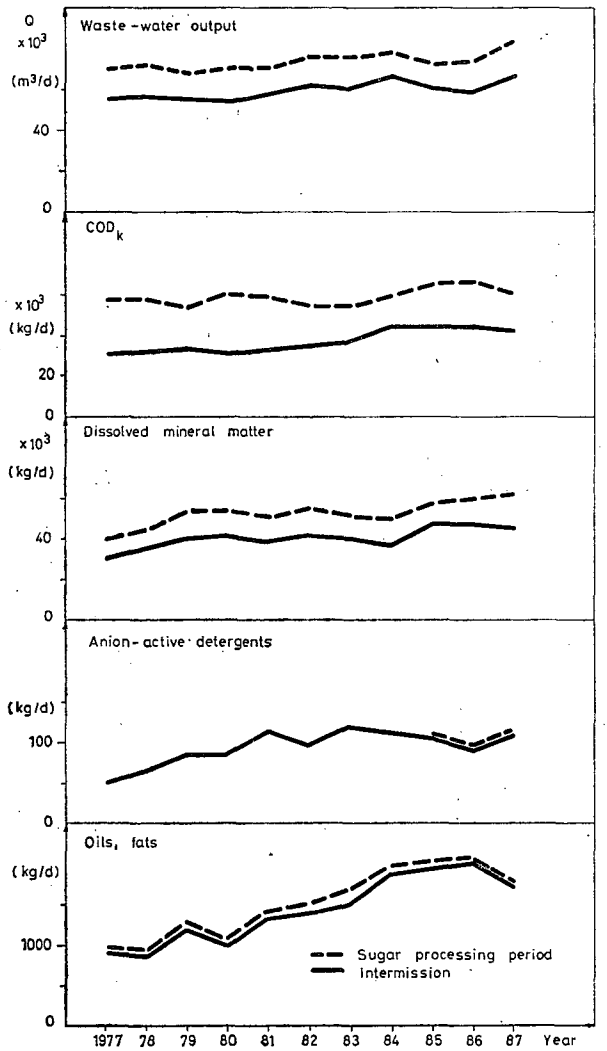

Fig. 2. Waste-water output and pollution load between 1977 and

waste-water. The relative output and various polluting components' content of the sources of waste-water studied are shown in Fig. 3 as the average values for the period between 1983 and 1986 (WAIJANDT 1987b).

From the point of view of the water quality of the Tisza the processing of sugar is a critical period, for which reason the relative values measured in this period are shown in Fig 3. The output and the content of the most important pollutants supplied by the sources studied are expressed on a percentage basis relative to the total waste-water data. The period of sugar processing lasts altogether for 100 days a year, for which reason in the right-hand side of Fig. 3 are shown the ratios of the load originating from the Szolnok Sugar Works (S), as well as the total load from the housing estates (ΣH) relative to the total load (Σ).

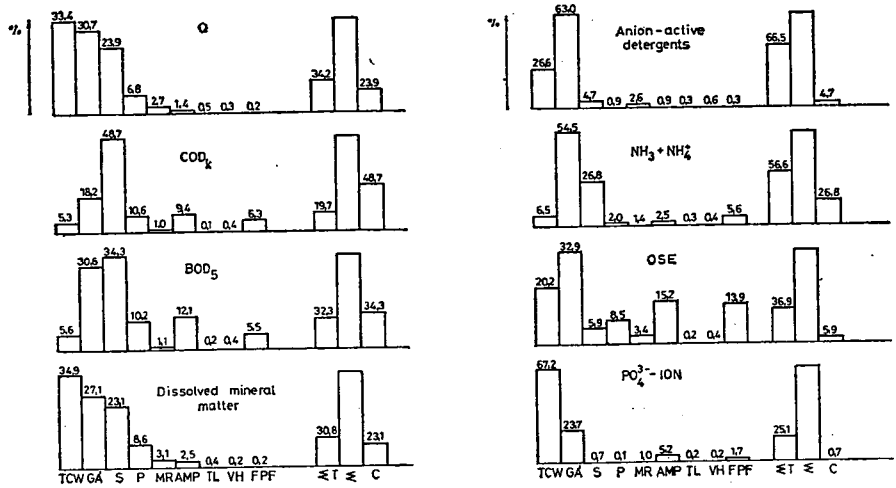

Fig. 3. Output and distribution of the polluting components of the sources of waste-water at Szolnok (average values from measuerements carried out between 1983 and 1986)

The main source of waste-water (25 000 m³/d) is the Tisza Chemical Works, somewhat less is being released into the Tisza by the main source of the household sewage-water — the transloading station at "Gábor Áron" square. Nearly half of the total organic matter (measured by the chromate method and expressed as chemical oxygen demand) is being loaded into the receptacle by the Szolnok Sugar Works. For this reason during a considerable part of the year (appr. 265 days) the organic matter load in the river drops roughly to the half of its maximal value. Similar is the situation with the biological oxygen demand. Except for the sugar processing period the major contribution to the organic matter load, which is biologically easily digested, originates from the sewage-water of the housing estates. It should be mentioned that the COD and BOD_5 load is nearly identical for the biggest and the smallest source of waste-water (Fig. 3)

The relative contributions to the mineral matter load (salts) closely follow the relative waste-water outputs of the sources studied. At the same time this indicates that the mineral matter load is not the most characteristic feature of the Szolnok waste-waters. (Both the Water Company of Szolnok as well as the industrial plants use water from the Tisza to produce drinking water and for industrial purposes respectively).

The major detergent load is being carried into the receptacle by the household sewage water. The same is valid for ammonium ions, too. It can be seen that the ammonium-ion load increases considerably in the Tisza during the sugar processing period.

The oil/fat load in the receptacle which has been measured by the gravimetrical organic solvent extract (OSE) method, originates in the first place from the household sewage-water but there are other sources contributing to the total load as well.

The main source of phosphate is the Tisza Chemical Works. By comparison with the data on detergents it can be concluded that the main part of the phosphate released into the Tisza is not bound to detergents.

2. Calculated effect of the pollution load on the Tisza water quality

From the data presented above it follows that a critical pollution load reaches the Tisza during the sugar processing period (September—December). The situation is better during the rest of the year. The sugar processing period is less favourable from the point of view of the receptacle, too, since at the time the water output of the Tisza decreases (Table 1) and the temperature of the water in the receptacle, which plays an important role in the selfpurification, is lower as well. For these reasons in what follows, the sugar processing period (September—December) and the intermission (January—August) will be discussed separately.

From the output of the waste-water, the pollution load and the massflow of the corresponding components in the Tisza it is possible to calculate the changes in the concentrations of various components under the influence of the pollution load. In the calculations it is presumed that the waste-water released into the Tisza gets completely mixed with the river water. In the calculations the following relation was used (PASZTÓ 1975):

$$C_T^x = \frac{\Sigma Q_W \cdot C_W + Q_T \cdot C_T}{Q_T + \Sigma Q_W}$$

C_T^x — concentration of the component studied in the Tisza after the inflow of the waste-water (g/m³)
C_T — concentration of the component studied in the Tisza before the inflow of the waste-water (g/m³)
Q_W — output of the waste-water (m³/s)
Q_T — flow-rate of the Tisza (m³/s)
C_W — concentration of the component studied in the waste-water (g/m³).

Table 1. *Average values of the Tisza water output and concentrations at Szolnok above the inflow of the Zagyva* (335,4)

year	1983.		1984.		1985.		1986.	
month	1—8	9—12	1—8	9—12	1—8	9—12	1—8	9—12
Q m³/s	587	147	407	382	781	351	659	162
COD_k g/m³	23.3	24.5	28.9	21.6	20.7	15.5	20.4	17.9
BOD_5 g/m³	4.71	3.72	6.26	4.49	5.15	3.88	5.16	4.11
Salts g/m³	267	363	284	289	271	316	261	354
Detergens (anion-active) g/m³	0.042	0.079	0.055	0.055	0.037	0.052	0.043	0.071
NH_4^+-ion g/m³	0.82	1.18	1.37	0.80	1.15	0.87	0.84	0.98
OSE g/m³	—	—	—	—	1.86	1.89	2.00	1.25
PO_5^3-ion g/m³	0.24	0.32	0.27	0.25	0.22	0.26	0.10	0.23
Dissolved oxygen g/m³	9.11	8.64	9.14	9.22	8.97	8.92	9.42	9.68
O_2 saturation (%)	84.6	81.3	78.6	81.3	79.0	80.0	85.3	87.4

In the calculations annual data on the average waste-water output and concentration values in the corresponding periods (sugar processing period and the intermission), as well as the flow-rate and the concentration values of the Tisza water between January—August and September—December, respectively, were used.

In Table 1 the average values of the Tisza flowrate and several important water quality characteristics are given for the above defined two periods. Depending on the Tisza flow-rate fluctuations the water output of the river in the period between September and December constitutes only 24—71% (on the average 40%) of the average value for the period between January and August. The lower values of COD_k and BOD_5 of the Tisza water reaching Szolnok in the sugar processing period have a favourable effect on the water quality. The mineral water content increases slightly in autumn in accordance with the higher water output in this period.

The concentration of detergents is at a satisfactory low level in both periods. The concentration of ammonium-ions shows considerable fluctuations. The dissolved oxygen and oxygen demand values hardly differ in the two periods, in general the values in September—December being slightly more favourable. The concentrations of dissolved phosphate are generally higher in September—December. The increase in the concentration was calculated according to the formula:

$$C = \frac{C_T^x}{C_T} \cdot 100 - 100\,(\%).$$

It can be conluded from Table 2 that in different years in the intermissions between the sugar processing periods (the greater part of the year) a considerable increase in the concentrations have not been observed even if the maximal values are concerned, except for the detergent and phosphate-ion concentrations. However, in the sugar processing period, except for the mineral matter, a considerable increase in the calculated concentrations is observed. It should be mentioned that due to the self-purification of the Tisza, the concentrations of the polluting components, except for the mineral matter, drop to a certain extent even before the complet mixing occurs. However the calculated increase in the concentrations does not indicate such a level in water quality deterioration which would justify its reassignment to a lower quality category as compared to the arriving water. The importance of the calculations is seen in the fact that they provide a basis for the estimations of the actual changes in the water quality.

3. Actual changes in the Tisza water quality

The changes in the water quality of the Tisza caused by the waste-waters of Szolnok should be measured in a reach where a complete mixing of the polluting materials with the river water had already occurred. (The waste-waters flow into the Tisza mainly in the bank regions, and a stretch of a considerable length is required for a complete mixing).

A regular network sampling reach where the mixing is presumably completed is situated at a distance of 75 km to the south from Szolnok at Tiszaug. By comparison of the water quality characteristics measured in this reach and immediately above Szolnok (Table 1), it is possible to estimate the actual changes occurring in the water quality due to the inflow of the waste-waters. (At Szolnok, above the inflow

Table 2. *Calculated increase in concentrations caused by the waste-waters*

	1983.		1984.		1985.		1986.		Min.		average		Max.	
	year								%		%		%	
month	1—8	9—12	1—8	9—12	1—8	9—12	1—8	9—12	1—8	9—12	1—8	9—12	1—8	9—12
COD_k	1.3	6.6	1.7	5.3	1.5	12.4	1.9	17.8	1.3	5.3	1.6	10.5	1.9	17.8
BOD_5	2.2	13.1	2.7	6.8	1.8	9.0	2.3	17.6	1.8	6.8	2.2	11.6	2.3	17.6
Salts	0.16	0.35	0.17	0.25	0.46	0.38	0.28	0.87	0.16	0.25	0.27	0.46	0.46	0.87
Detergents (anion-active)	4.5	9.1	5.6	5.9	3.9	6.4	4.6	8.8	3.9	5.9	4.7	7.5	5.6	9.2
NH_4^+	2.1	7.1	3.0	9.1	1.5	8.22	2.4	9.4	1.5	7.1	2.3	8.4	3.0	9.4
OSE	—	—	—	—	1.4	3.3	1.7	11.3	1.4	3.3	1.5	7.3	1.7	11.3
PO_4^{3-}	5.9	11.7	7.7	8.8	4.6	8.7	15.6	53.2	4.6	8.7	8.5	20.6	15.6	53.2

Table 3. *Calculated and measured average concentrations in the reach at Tiszaug in case of the least favourable pollution load conditions*

	COD_k	BOD_5	Salts	Detergens (anion-active)	NH_4^+-ion	OSE	PO_4^{3-}-ion
			g/m³				
C_T	17.9	4.11	354	0.079	0.98	1.25	0.23
C_T^x	21.1	4.83	357	0.086	1.07	1.39	0.35
$C_{T.UG}$	18.6	4.47	359	0.076	1.03	2.51	0.30
$c_{I.C.}$	25.0	5.0	500	0.20	1.0	—	0.30
quality category at Tiszaug	I.	I.	I.	I.	II.	—	I.

C_T — average concentration in the Tisza reach immediately above Szolnok
C_T^x — calculated average concentration after the inflow of the waste-waters of Szolnok
$C_{T.UG}$ — average concentration measured in the reach at Tiszaug
$C_{I.C.}$ — limiting value for the I. class water quality

of the Zagyva river 52, at Tiszaug 26 midstream samples have been studied every year.)

For every component those least favourable years were selected from Table 2, in which the highest ratios of the pollution load and the massflow in the Tisza for the same component were observed; for the selected years the values of the average concentrations measured above Szolnok and at Tiszaug, as well as the values calculated for Tiszaug according to the method described above for the critical months — September—December, are given in Table 3. Due to the self purification of the river, for most of the components studied (COD_k, BOD_5, detergents, ammonium-ion) the values measured at Tiszaug are lower than the calculated ones.

For the sake of completeness it should be mentioned that pollution load occurs at Martfű, too, between the reaches above the Zagyva mouth and that at Tiszaug but its influence is practically negligible (WAIJANDT 1987a, 1988). The streams flowing into the Tisza between these two reaches (Zagyva, Gerje-Perje, Körös-brook, Peitsik-brook) are relatively polluted and cause further considerable increase in the Tisza load. The pollution brought into the Tisza by these four springs together as compared to the waste-water of Szolnok measures 0,58 for the COD_k value, 0,39 for BOD_5, 7,4 for mineral matter, 1,05 for detergents and 1,1 for phosphate. Thus, during the sugar processing period the load of these springs is not negligible as compared to the pollution released at Szolnok, moreover, for three components it is similar or even exceeding the load at Szolnok.

The average values of the water quality components showing normal distribution, measured in the reaches above Szolnok and at Tiszaug can be compared with the help of the so-called two-sample t-test (FÉLIX, BLAHA 1964, VINCZE 1975).

The average values for COD_k, BOD_5, dissolved mineral matter, anion-active detergent concentration obtained in the four years' period between 1983 and 1986 in the two reaches were identical, with the level of significance corresponding to 95% (The distribution of ammonium-ion and organic solvent extract (OSE) differs from normal, and for this reason the t-test is not applicable to the average values of these components.)

The differences in the water quality of the two reaches can be illustrated in full details with the help of empirical distribution curves (WAIJANDT 1987a, 1988).

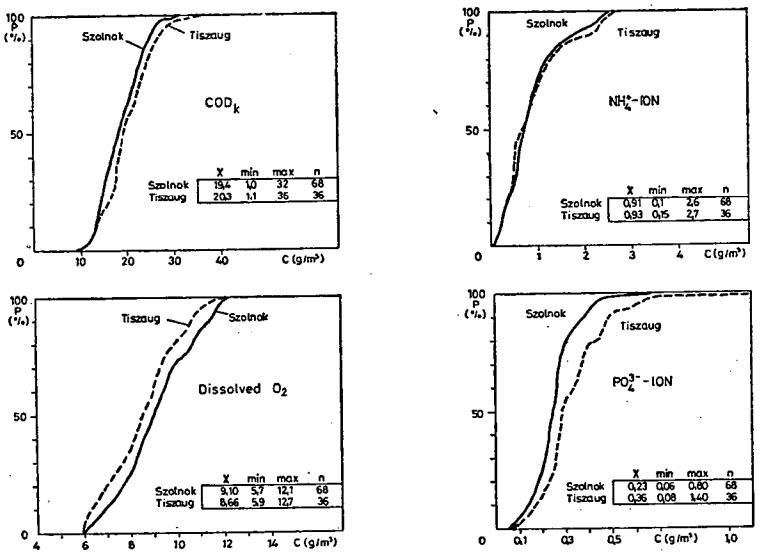

Fig. 4. Empirical distribution curves of the measurements carried out in September—December in the period between 1983 and 1986 above Szolnok and in the reach at Tiszaug

The difference in COD_k values during the critical months (September—December) is not big but still clearly seen (Fig. 4). The dissolved oxygen distribution curves reflect a slightly inferior water quality in the reach at Tiszaug. The ammonium-ion concentrations do not show significant differences. The differences in water quality as far as the dissolved phosphate-ion is concerned were proven both by the average values and the empirical distribution curves. In the nitrate-ion concentration curves no differences were observed, and the average values were in good agreement as well.

In the intermission between the sugar processing periods (the greater part of the year), except for the dissolved phosphate-ion content, the waste-waters of Szolnok do not exert a significant influence on the Tisza water quality (Table 2). In the first eight months of the year due on the one hand to the diluting effect of the higher output of the river, and on the other hand — to the faster rate of the self-purification caused by the higher temperature of the water during the summer months, the effect of the pollution load on the water quality decreases.

Conclusions

— In order to gain more reliable data on the changes in the pollution load from the main sources of waste-water, it is desirable to increase the frequency of the water quality tests.

— The waste-waters of Szolnok as shown by the measurements of the major components do not cause such a deterioration of the Tisza water quality, which would justify its reassignment to a lower quality category. As far as the dissolved mineral matter is concerned, its modifying effect on the water quality is insignificant. The most pronounced changes caused by the waste-waters in the reach below

Szolnok consist in the rise of COD_k values and the concentration of the dissolved phosphate-ions

— The small tributaries of the Tisza in the reach below Szolnok contribute to a significant extent to the deterioration of the water quality in this region.

— From the point of view of the conservation of the water quality of the Tisza, as a first step an adequate purification of the waste-water of the Szolnok Sugar Works seems to be of utmost importance.

The reach of the river Tisza between the mouth of the river Sajó and the town of Szolnok can be characterized by an improvement of the water quality.

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In the vicinity of Szolnok the Tisza is being loaded significantly by the pollution coming from 5 industrial and 4 residential areas, the waste-waters of which show considerable quantitative and qualitative differences. Both the output of the waste-water released and the load of certain polluting components showed a slight increase in the period between 1977 and 1987. Nearly half of the organic matter is being released into the Tisza by the Szolnok Sugar Works during the 100 days' period of sugar processing. The major part of the detergent, ammouim-ion, fat and oil load is of household origin.

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The actual deterioration of the water quality was less expressed than could be expected from calculations due to the self-purification of the river and did not justify its reassignment to lower quality categories for none of the quality parameters.

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Szolnok szennyvizeinek hatása a Tisza vízminőségére

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Kivonat

A sajó torkolata és Szolnok között a folyóra a vízminőség javulása a jellemző. A Tisza, a folyó középső szakaszán csak Szolnoknál kap jelentős szennyezőanyag-terhelést.

A Tiszát Szolnoknál 5 ipari és 4 települési jellegű jelentős kibocsátó szennyezőanyag-terhelése éri, amelyek jelentősen eltérő szennyvízmennyiséggel és minőséggel jellemezhetők. Mind a kibocsátott szennyvíz mennyisége, mind az egyes szennyezőanyag komponensek terhelése kismértékű növekedést mutatott 1977 és 1987 között. A szervesanyag-terhelés csaknem felét a cukorgyártás mintegy 100 napos időszakában a Szolnoki Cukorgyár juttatja a Tiszába. A mosószerek, az ammónium-ion, a zsírok, olajok terhelésének legnagyobb része lakossági eredetű.

A szennyezőanyag-terhelés számított hatása a Tisza vízminőségére csak a cukorgyári kampány (szeptember—december) időszakában említésre méltó. Ezért a létrejött vízminőségromlást kizárólag ezen időszakban vizsgáltuk részletesen. A szervesanyag, az oldott oxigén és a foszfát-ion koncentráció esetében jól megmutatkozott a vízminőségi romlás a Szolnok feletti és Szolnok alatti (tiszaugi) szelvények vízminőségének összehasonlításában (minimum, maximum átlagérték, eloszlásgörbék).

A létrejött vízminőségromlás a folyó öntisztulása miatt kisebb a számítottnál és nem hozott létre vízminőségi osztályváltozást egyetlen vízminőségi komponens esetében sem.

Влияние сточных вод Солнока на качество воды реки Тиса

Й. Байандт
Управление охраны окружающей среды и вод среднего течения Тисы,
Солнок, Тисалигет

Резюме

Для отрезка Тисы между устьем Шайо и Солноком характерно улучшение качества воды. В среднем течении значительное загрязнение поступает в Тису только у Солнока.

В районе Солнока расположено пять источников промышленного и четыре источника бытового характера, значительно загрязняющих Тису, сточные воды которых различаются в качественном и количественном отношении. В период между 1977 г. и 1987 г. наблюдалось известное увеличение как количества сточных вод, так и нагрузки отделных компонентов загрязнения. Почти половина органических веществ поступает в Тису с Сахарного завода в Солноке во время продолжающегося 100 дней процесса производства сахара. Моющие средства, ионы аммония, жиры и масла, поступающие в реку, в обльшинстве своем бытового происхождения.

Рассчеты показывают, что влияние загрязнения на качество воды в Тисе заслуживает специального внимания лишь в период производства сахара. В связи с этим ухудшение качества воды исследовали подробно только в этот период. В сравнительных анализах качества воды (минимальные и максимальные средние значения, кривые распределения) над и под (Тисауг) Солноком доказано ухудшение качества воды в отношении содержания органических веществ, растворенного кислорода, концентрации фосфатных ионов.

Фактическое ухудщение качества воды меньше рассчетного вследствие процесса самоочищения и не приводит к изменению категории качества воды, судя по любому из характеризующих его параметров.

Utjecaj prljave vode na Tisi kod Solnoka

WALJANDT J.
Directorate of Environmental and Water Conservancy of the Central Tisa region

Abstrakt

Između grla Šajo i grada Solnok kvalitet vode se pobojšava. Reka Tisa je opterećena samo na srednjem otseku sa Solnoškom prljavom vodom.

Kod Solnoka pet fabrika i četiri deo grada ispušta prljavu vodu u reku (vidi sliku), kvalitet količine prljave vode je dosta diferencijalna.

I količina ispuštane prljave vode i komponenti prljave vode pokazali su malo povećanje u periodu 1977 i 1987 god. (2. slika).

Polovine opterećenja sa organskim materijama dolazi iz fabrike šećera (u toku od 100 dana). Deterdženti, azot-joni, masti i ulje proizlazu naročito od stanovništva. (3. slika).

Dejstvo prljave vode za reku je značajan samo za vrijeme kampanja fabrike šećera (sept.—dec.) (2. tabela). Zato je izučen kvarenja kvaliteta vode samo u tom terminu.

Koncentracija organske materije, rastvorenog kiseonika i fosfat-jona je dosta veća u izvađenim primercima ispod Solnoka u poređenju gornjog dela Solnoka (vidi se od grafikona: min., maks., prosečne krive, 4. slika). Kvarenje kvaliteta vode je dosta veća od prirodne regeneracije reke i nije postiglo rezultate da bi podigao kvalitet vode barem sa jednim stepenom.

COMPREHENSIVE EVALUATION OF THE RESULTS OF THE DAPHNIA TEST CARRIED OUT AT THE TISZA-SECTION AND MAJOR DISTRICT WATERS IN SZOLNOK COUNTY (1977—87)

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Abstract

Between 1977—1987 acute toxicological studies were carried out with *Daphnia magna* at eight points of the Tisza-section in Szolnok county and at the major district waters of the region. It was determined that in the periods studied 19,4% of the Tisza water samples and 4,8% of the samples originating from the district waters were of toxic effect on the *Daphnia*. From 1975 on the positivity of the Tisza water samples taken frequently above the area of the Surface Water Works in Szolnok showed strongly decreasing tendency, falling back from 74% to 1%. The observed phenomenon can be explained most probably by the beneficial effect of the Kisköre storage lake, since the drastic decrease of the high rate of objection observed previously coincided with the filling up of the lake between 1979—1983.

Introduction

Since 1974 the Water Microbiological Laboratory of the Service of Public Health and Epidemiology of Szolnok County carries out regular chemical, bacteriological, biological and toxicological studies with the aim to reveal the environmental effects. Within the complex hygienic programme the importance of these acute toxicological studies was emphasized several times, in the frame of which biological tests were accomplished in respect to the Tisza river in Szolnok county, and the major district waters of the region, as well as the drinking water of the city of Szolnok, provided from the Tisza river. Here we would refer to some of the data published earlier on this topic (CSÉPAI 1975, 1976, SCHIEFNER 1979, KÁDÁR 1983). In the following a review is given on the results of the *Daphnia* toxicity tests carried out in the period between 1977 and November 30, 1983.

Materials and Methods

The water samples were taken from the sites given in Fig. 1 and the tables, 5 cm below the surface, transported in refrigerated state and processed within 24 hours after temperation to room temperature. The *Daphnia* toxicity tests were performed and the results evaluated according to the specifications of the Hungarian *Daphnia* test (Water Toxicological Studies, 1982). The principle

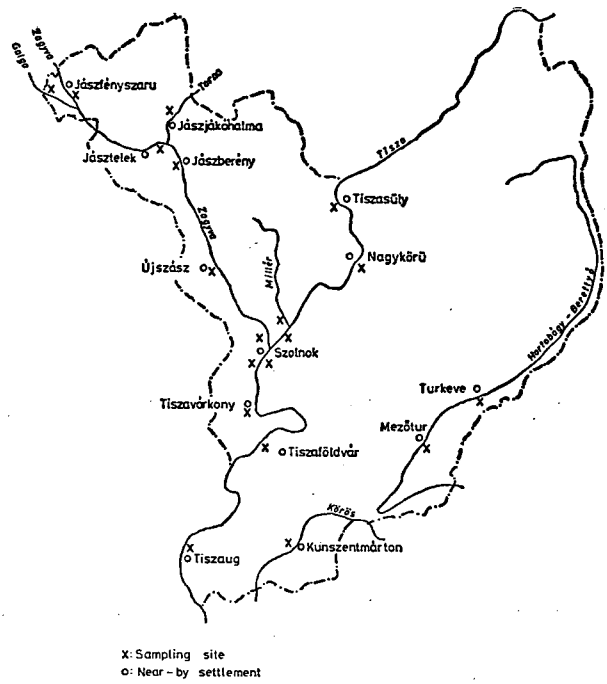

Fig. 1. Regional distribution of the sampling sites

of the test is that for negative qualify those samples in which half of the *Daphnia* survive a 48 hours' period of exposure; in the opposite case, the result of the *Daphnia* test is regarded as positive.

The *Daphnia* toxicity tests were carried out using 4 days-old organisms of the strain *Daphnia magna S* cultivated in our laboratory. The sensitivity of *Daphnia* to chromate corresponded to the requirements of the Hungarian *Daphnia* test mentioned above.

Results and Evaluation

In connection with the results to be described below, we should mention that the findings of the tests carried out in the period 1974—1978 at the Tisza-section in Szolnok county have been previously discussed by SCHIEFNER (1979) as a part of the studies performed on the whole length of the river on the territory of Hungary.

According to our results, within the period studied 19,4% of the total samples taken from the Tisza-section in Szolnok county proved to be *Daphnia* positive (Table 1). The data show that the river water is toxic for *Daphnia* primarily in autumn, winter and early spring months. These findings prove the role played by the temperature factors in the realization of the effect of the toxic microcontaminants occuring in the Tisza water. The toxicity of the district waters was low: the positive samples amount to 4,8% of the total samples studied (Table 2). From the point of view of the sesonal distribution of the positive results, the relationship is similar to that experienced during the course of the studies at the Tisza river.

Tests of the unrefined surface water obtained by the Szolnok Surface Water Works were carried out by us at least once, more often twice a week. The results are shown in Fig. 2.

Table 1. *Months*

Szampling sites Tisza		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	1977—1987 Total	
Tiszasüly	positive	2	2	1	—	—	—	—	2	1	—	1	1	10	positive
right bank	negative	1	5	2	9	1	10	—	8	—	10	—	7	52	negative
														62	total
Nagykörű	positive	2	1	1	—	—	—	—	2	—	1	1	1	9	positive
right bank	negative	—	2	1	3	1	4	—	2	1	3	—	2	19	negative
														28	total
Unrefined water															
obtained by	positive	2	3	1	—	—	—	—	3	1	2	1	2	15	positive
Szolnok Water	negative	—	4	2	9	1	10	—	7	—	8	—	6	47	negative
Works														62	total
Szolnok															
left bank	positive	2	2	1	—	—	—	—	2	1	2	1	2	13	positive
below Zagyva	negative	—	4	2	9	1	9	—	8	—	8	—	6	47	negative
														60	total
Szolnok															
right bank	positive	2	1	1	—	—	1	—	2	1	2	1	2	13	positive
below Zagyva	negative	—	1	1	3	1	4	—	2	—	2	—	1	15	negative
														28	total
Tiszaföldvár	positive	—	2	1	—	—	—	—	1	—	2	—	—	7	positive
left bank	negative	1	4	2	9	—	10	—	9	1	8	—	7	51	negative
														58	total
Tiszavárkony	positive	1	2	—	—	—	—	—	1	—	2	1	—	7	positive
right bank	negative	—	4	3	9	1	10	—	9	1	8	—	8	53	negative
														60	total
Tiszazug, from	positive	1	1	1	—	—	—	—	1	—	2	1	—	7	positive
the bridge,	negative	—	6	2	9	—	10	—	9	1	8	—	7	52	negative
middle line														59	total
Positive samples		12	14	7	—	—	1	—	14	4	13	8	8	81	positive (19,4%)
Negative samples		1	30	15	60	6	67	—	54	4	55	—	44	336	negative
Total		13	44	22	60	6	68	—	68	8	68	8	52	417	total

Table 2. *Months*

Sampling sites (in every case from the bridge, middle line)		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	1977—1987 Total	
Galga															
above Jászfényszaru	positive	—	—	—	—	1	—	—	—	2	—	—	—	3	positive
	negative	3	1	9	3	7	2	5	2	8	1	10	—	51	negative
														54	total
Tarna															
above Jászjákóhalma	positive	—	—	—	—	—	—	—	—	3	—	1	—	4	positive
	negative	3	1	9	3	8	2	5	2	7	1	9	—	50	negative
														54	total
Zagyva															
below Jászfényszaru	positive	—	—	—	—	1	—	—	—	1	—	1	—	3	positive
	negative	3	1	9	2	7	2	5	2	9	1	9	—	50	negative
														53	total
Zagyva	positive	—	—	—	—	1	—	—	—	2	—	—	—	3	positive
below Jászberény	negative	—	1	3	2	2	1	—	1	2	1	4	—	17	negative
														20	total
Zagyva	positive	—	—	—	—	—	—	—	—	1	—	—	—	1	positive
below Jásztelek	negative	3	1	8	3	8	2	5	2	9	1	10	—	52	negative
														53	total
Zagyva	positive	—	—	—	—	1	—	—	—	2	—	—	—	3	positive
below Újszász	negative	—	1	2	2	2	1	—	1	2	1	4	—	16	negative
														19	total
Zagyva															
Szolnok, below	positive	—	—	—	—	1	—	—	—	1	1	—	—	3	positive
TB Hospital	negative	3	1	9	3	7	2	5	2	9	—	10	—	51	negative
														54	total
Miller	positive	—	—	—	—	1	—	—	—	—	—	—	—	1	positive
above Szolnok	negative	2	1	8	3	7	2	5	2	10	1	10	—	51	negative
														52	total
Körös	positive	—	—	—	—	—	—	—	—	—	—	—	—	—	positive
Kunszentmárton	negative	3	1	9	3	8	2	5	2	10	1	10	—	54	negative
														54	total
Hortobágy-Berettyó	positive	1	—	—	—	1	—	—	—	—	—	1	—	3	positive
below Mezőtúr	negative	2	1	9	3	7	2	5	2	10	1	9	—	51	negative
														54	total
Hortobágy-Berettyó	positive	—	—	—	—	1	—	—	—	—	—	—	—	1	positive
below Túrkeve	negative	3	1	8	3	7	2	5	2	10	—	10	—	51	negative
														52	total
Positive samples		1	—	—	—	8	—	—	—	12	1	3		25	positive (4,8%)
Negative samples		25	11	83	30	70	20	45	20	86	9	95		494	negative

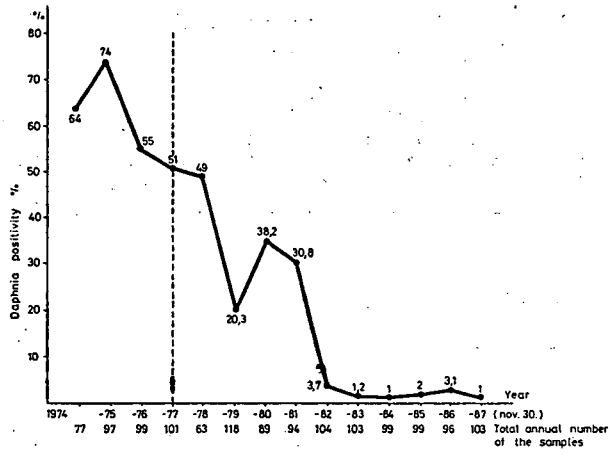

Fig. 2. The *Daphnia*-test positive results in the samples of unrefined water obtained by the Szolnok Surface Water Works between 1977—1987

The aim of the biological tests is to reveal the toxic effects (microcontaminations, unknown interactive effects) which can not be detected by analytical methods. For these reasons we are not in the position to identify the chemical background of the observed phenomena. However, we feel that the reasons for the significant decrease of toxicity reflected by our results (Fig. 2) can be satisfactory interpreted. Namely, the drastic improvement coincides with the filling up of the Kisköre storage lake (lately named Tisza-lake) to its present level in the period 1979—1982. The significant drop in the toxicity of the storage lake can be due to the simultaneous effect of the favourable sedimentation originating from the decrease of the flow-rate, the increase in the intensity of the volumetric irradiation by the sunlight and in the oxigen uptake from the air due to the increased surface, and finally to the filtering effect of the aquatic vegetation. Our calculations based on the available data (volume and surface of the stored water, average water output) show that the operation of the storage lake led to 3,9-fold increase in the specific surface per unit volume of the water, and 3,1-fold decrease in the average flow-rate as compared to that of the river. Although quantitative estimation can not be given, an inspection of the storage lake shows a convincing increase in the vegetation.

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A Szolnok megyei Tisza-szakasz és a fontosabb mellékvizek Daphnia-teszt eredményeinek összefoglaló értékelése (1977—1987)

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Kivonat

1977—1987 között akut toxikológiai vizsgálatokat végeztünk Daphniákkal a Tisza Szolnok megyei szakaszának 6 pontján és a megye fontosabb mellékvizein. Megállapítottuk, hogy a vizsgált időszakban a Tisza hossz-szelvény víz mintáinak 18,3%-a, a mellékvizekből származó minták 4,3%-at volt Daphniákra mérgező hatású. A szolnoki felszíni vízmű felett nagy gyakorisággal vett Tisza víz minták pozitivitása 1975. után napjainkig erősen csökkenő tendenciát mutat; 74%-ról 1%-ra esett vissza. E jelenség okai nagy valószínűséggel olyan kedvező hatások érvényesülésével magyarázhatók, ahol az összetevők között jelentős szerepe van a Kiskörei víztározónak, mert környezeti adottságai révén nagy mértékben elősegíti a szerves- és toxikus anyagok kémiai és mikrobiológiai oxidációját. De nem hagyhatjuk figyelmen kívül a környezetvédelem területén hozott állami intézkedések hatását sem az ugyancsak lassan, de a társadalmi céloknak megfelelő irányban változó lakossági szemlélettel együtt.

Общая оценка результатов тестов, основанных на Daphnia, воды реки Тиса и ее основных притоков, протекающих по территории области Солнок (1977—1897 гг.)

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Резюме

В период 1977—87 гг. проводились токсикологические исследования при помощи теста на Daphnia magna в восьми участках Тисы и ее основных притоков, протекающих по территорри области Солнок. Было установлено, что за исследуемый период 19,4% водных проб продольного отрезка Тисы и 4,8% проб ее притоков оказались токсичными для Daphnia.

Пробы, которые брали с большой частотой над водонапорной станцией в Солноке свидетельствуют о тенденции значительного снижения позитивности водных проб Тисы с 1975 г. до настоящего времени (снижение с 74% до 1%). Предполагается, что возможным объяснением наблюдаемых результатов является благоприятное влияние водохранилища в Кишкёре, поскольку резкое снижение наблюдаемого ранее высокого процента позитивности совпало по времени с эксплуатационным заполнением водохранилища в Кишкёре в период 1979—1983 гг.

Ukratko procenjivanje rezultate test-Daphnie vršenim u reci Tisa i u važnijim sporednim vodama u županiji Solnok

F. ČEPAI

Abstrakt

Uzvrišili smo akutne toksikološke istraživanje sa Daphnijama na 6 tačci Tise u županiji Solnok i u važnijim sporednim vodama između 1977—87 god. Došli smo do zaključka da za vreme istraživanja Tise je bila toksična u 18,3% na Daphnije a sporedne vode u 4,3%.

Od 1975. godine pozitivitet izvađenog vodenog uzorka iz Tise kod Solnoškog hidrocentrala pokazuje opadanje tendencije, pad je od 74% do 1%. Ova pojava opravda se sa takvim povoljnim uslovima gde između ostalim gradientima Kiškere Rezervoar za Vodu igra veliku ulogu, on ima takvih ekoloških okolnosti koji omogućavaju što bolju hemijsku i mikrobiološku oksidaciju organskim i toksičnim materijama. Ali da ne izostavimo državne odredbe za odbranu ekoloških okolnosti koje zajedno sa mentalitetom stanovništva lagano ali sigurno se menjaju prema društvenim ciljama.

Table 1. *Results of the Daphnia-test carried out at the Tisza-section in Szolnok County between 1977—1987*

Table 2. *Results of the Daphnia-test carried out at the district waters of Szolnok County between 1977—1987*

LIMNODRILUS HOFFMEISTERI CLAPAREDE, 1862 AS A DOMINANT SPECIES IN THE TISA DEAD-ARM (ČURUG—BISERNO OSTRVO) OLIGOCHAETA COMMUNITY

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Abstract

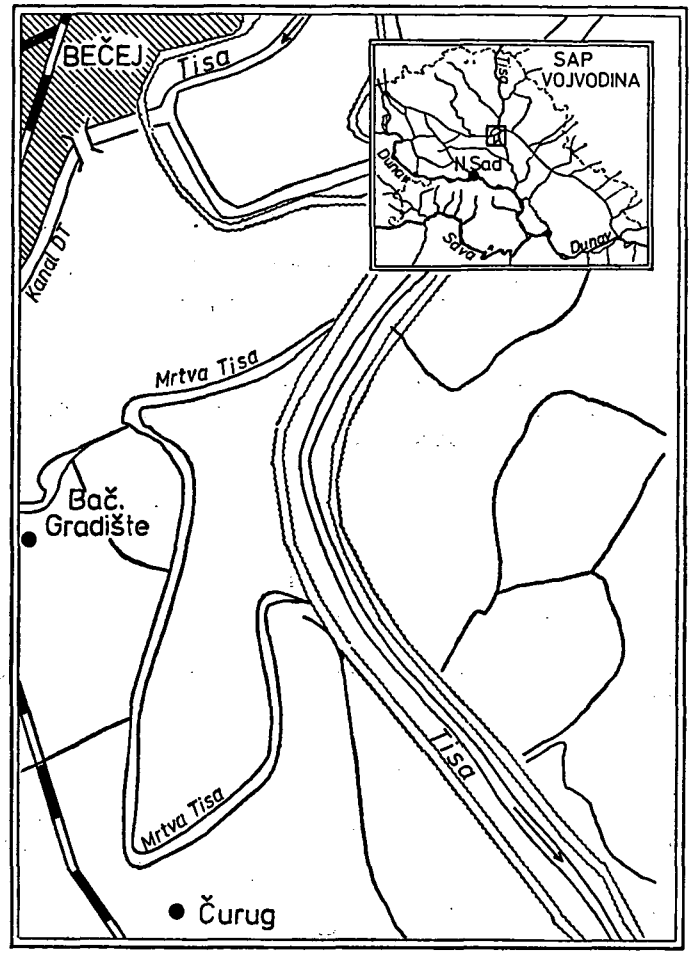
In the 1983—1988 period 11 oligochaeta have been found in the Mrtva Tisa Oligochaeta community from Naididae and Tubificidae family. *Limnodrilus hoffmeisteri* has been a dominant species in all the samples. The relative abundance, expressed as the percentage of this species has shown an increasing tendency up to 67%. The increase in the percentage of this species is closely related to the increase in the Oligochaeta dynamics of abundance. This in durn, leads to changes in the Oligochaeta community structure.

Introduction

The fauna studies of the Mrtva Tisa bottom are of recent date (initiated in 1983). Oligochaeta community as an eutrophication indicator in the Mrtva Tisa has been studied by DUKIĆ 1987 in the period from 1983 to 1987. Within this short period, it has been found that *L. hoffmeisteri* species relative abundance is constantly reflected by the increasing tendency. Many research workers have been involved in the studies of *L. hoffmeisteri* species.

According to BRINKHURST 1969, this species is present in fresh waters of variable quality and its progressive domination in the benthic community is closely related to the organic pollution level. PODUBNAJA (1972), however, in her research work has demonstrated that this species is widely spread, inhabiting waters polluted with different types of pollutants. *L. hoffmeisteri* and *L. udekemianus* species development cycle and production in the organic matter reach mudd has been studied by LAZIM and LEARNER 1986.

These authors have come to a conclusion that *L. hoffmeisteri* had the highest relative abundance within the total *Tubificidae* production. For these reason have we decided to conduct a more detailed study of this species, which dominates in the Mrtva Tisa.



Materials and Methods

The fauna samples of the Mrtva Tisa bottom have been collected according to seasons, in the 1983—1988 period. The mudd has been collected by "Ekman Birge" type dredging machine. The collected material has been prepared in the laboratory by standard method. Determination has been carried out on live Oligochaeta specimen. The number of individuals is presented as a total number of individuals per m^2 of the surveyed area.

The correlation is calculated on the basis of the total number of Oligochaeta individuals and those of *L. hoffmesiteri* species.

Results and Discussion

In the qualitative studies of the Oligochaeta community of the Mrtva Tisa bottom fauna, 11 Oligochaeta species of six genera and two families, Naididae and Tubificidae have been found, as follows: *Dero digitata, D. obtusa, Stylaria lacustris, Limnodrilus, sp. L. hoffmeisteri, L. claparedeanus, L. udekemianus, L. helveticus,*

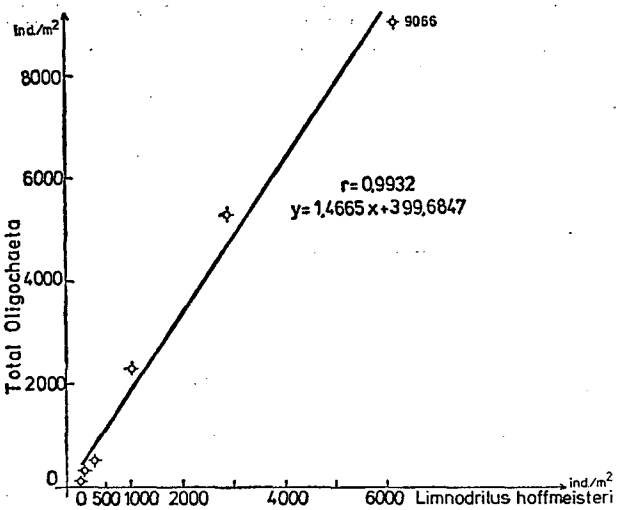


Fig. 1. Correlation of Oligochaeta total number and number of *Limnodrilus hoffmeisteri*

Psamoryctides barbatus, P. albicola, Potamothrix hammoniensis and *Tubifex tubifex. L. hoffmeisteri* has been a dominant species in all the samples in the 1983—1988 period.

This is confirmed by the relative abundance, as shown in Fig. 1. The mean percentage of this species has been increased from 22% in 1983, to 67% in 1988. The Mrtva Tisa mudd is of a soft, consistent state, black color, with ample detritus of the plant and animal origin, rich in organic matter, and highly suitable for the observed species development.

Similar results have been obtained by LAZIM and LEARNER, 1986. In the organic enriched fine sediment, *L. hoffmeisteri* species had the largest percentage in the total Tubificidae production. Research work carried out by BRINKHURST 1969, LANG 1984, MILBRINK 1980., and others state a large number of this species in the organic matter rich mudd. Because of that, LANG 1984 has classified them as eutrophic species.

Therefore, this species in the community with Tubificidae defines the Mrtva Tisa environment as eutrophic. The quantitative analysis contributes to this fact,

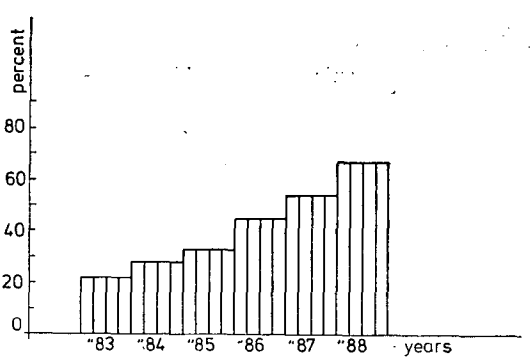


Fig. 2. Participatin percent of *Limnodrilus hoffmeisteri* individual in Oligochaeta total number

showing a striking increase in the number of Oligochaeta individuals, up to 9066 ind/m² in 1988. This is also characteristic of eutrophic waters.

The calculated relation between the total number of Oligochaeta individuals and those of *L. hoffmeisteri* reveals a close correlation between these two parameters.

This is also supported by the correlation coefficient significance (Fig. 2), thus *L. hoffmeisteri* species contributes the most to an increase in the Mrtva Tisa abundance dynamics. It has suceeded in adjusting to the conditions of the organic matter rich sediment, multiplying plentifully and thus disturbing the Oligochaeta community structure ratio in this stagnant tributary.

Conclusion

In the 1983—1988 period 11 Oligochaeta species have been defined in the Mrtva Tisa Oligochaeta community, from six genera and two families: Naididae and Tubificidae. *Limnodrilus hoffmeisteri* has been a dominant species in all the samples.

The relative abundance expressed as the percentage of species has shown an increasing tendency, even up to 67%. The correlation between the total number of Oligochaeta individuals and those of *L. hoffmeisteri* species has been very narrow (the correlation coefficient r=0,9932), meaning that *L. hoffmeisteri* is a major cause for an increase in the abundance dynamics of Oligochaeta in the Mrtva Tisa. It has been well adjusted to the conditions of an organic matter rich sediment, it has also multiplied abundantly, disturbing the Oligochaeta community structure in this stagnant tributary.

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A Holt-Tisza (Čurug—Biserno Ostrvo) Oligochaeta közösségének dinamikája

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Kivonat

A Holt-Tisza komplex hidrobiológiai kutatásainak szerves tartozéka az Oligochaeták vizsgálata is. Megállapítást nyert hogy az 1983—1985-ös időszakban strukturális változás állt be az Oligochaeta közösség összetételében. Mennyiségi analízis tekintetében a domináns *Limnodrilus hoffmeisteri* relatív abundaciája évről évre növekedett. Az oligochaeták mennyiségi gyarapodásán belül a *L. hoffmeisteri* feldúsult részesedése szoros korrelatív kapcsolatban áll, a szerves megterhelés következtében, a holtágra jellemző felgyorsított eutrofizációs folyamattal.

Динамика сообщества Oligochaeta в Мертвой Тисе (Чуруг — Бисерно Острво)

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Резюме

Изучение *Oligohaeta* является органической частью комплексного гидробиологического исследования Мертвой Тисы. Было установлено, что в период 1983—85 гг. в составе сообщества Oligohaeta произошли структурные изменения. В результате количественного анализа обнаружено увеличение из года в год относительного избытка доминантного вида *Limnodrilus hoffmeisteri.* В рамках количественного увеличения Oligohaeta, относительное преобладание *L. hoffmeisteri* находится в тесной корреляции с характерным для мертвого русла ускоренным процессом эутрофизации вследствие его органической нагрузки.

Limnodrilus hoffmeisteri claparede, 1862 kao dominantna vrsta u zajednici Oligochaeta u mrtvoj Tisi (Čurug—Biserno Ostrvo)

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Abstrakt

U periodu od 1983—1988 godine u oligohetnoj zajednici Mrtva Tisa je konstatovano 11 vrsta oligoheta iz familije Naididae i Tubificidae. U svim uzorcima je dominirala vrsta *Limnodrilus hoffmeisteri.* Relativna abundantnost, prikazana preko procentualne zastupljenosti ove vrste pokazuje tendenciju njenog porasta i do 67%.

Procentualno povecanje zastupljenosti ove vrste je u uskoj korelaciji sa povećanjem dinamike brojnosti oligoheta, a to dovodi do promena u strukturi oligohetne zajednice.

THE COMPOSITION AND THE DYNAMICS IN POPULATION OF THE DOMINANT CRUSTACEA SPECIES IN MRTVA TISA

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Abstract

In the period of investigation from 1987 to 1988, a total of 19 Cladocera and 8 Copepoda from Crustacea species was found in Mrtva Tisa.

There was 13 and 18 Cladocera species in both years respectively, i.e. 8 and 6 Copepoda species. The largest number of species appeared in the summer (12 and 14 Cladocera and 6 Copepoda species).

Dominant species were: *B. longirostris, Ch. sphaericus, D. brachyurum, S. crystalina, C. vicinus* and *Th. crassus* with highest order of domination (Dt) and rather low frequency of domination (DF), while higher frequency index (pF) and lower order of domination was observed for the following species: *D. cucullata, E. gracilis, E. serrulatus.*

Among physical and chemical parameters, t °C of water varied the most. During the summer months it was 26 °C. A Decrease in the amount of dissolved oxygen down to 6,8 mg·dm^{-3}, followed the increase of water temperature.

Quantitative composition varied also. Total values were greater in 1987. The maximum values for Cladocera and Copepoda (59 and 217 ind·dm^{-3}) were recorded during the summer period.

For nauplius however the maximum were in the spring (171). In 1988, maximum values for all three groups were recorded in the summer (Cladocera 117, Copepoda 187 and nauplius 127 ind·dm^{-3})

Introduction

Crustacea, i.e. Copepoda in the Dead Tisa, Čurug-Biserno, an island-bychannel of the Tisa river were the subject of our former investigations (RATAJAC 1975, 1981). This ecosystem is biologicaly very productive, providing suitable conditions for the existance of a large number of fish species. Since zooplankton represents a significant component in the dies of many fish species, the aim of this experiment was to investigate the composition and dynamics of population of the dominant Crustacea species.

Methods and Materials

The material in the Dead Tisa near Čurug was collected during 1987 and 1988. In the first year all seasonal aspects were encompassed, while in the second year samples were taken in monthly intervals. Parallel to sampling for biological analysis, certain physical and chemical parametres were also measured: t °C of water, and pH as well as oxygen dissolved in water. The material was

collected and threated with standard methods. Frequency index (pF), frequency of domination (DF) and order of domination (Dt) was calculated.

$$pF = \frac{m}{n} \cdot 100 \quad DF = \frac{md}{n} \cdot 100 \quad Dt = \frac{DF}{pF} \cdot 100$$

n = total number of samples
m = number of samples in which species were present
md= number of samples in which species were dominant

Results and Discussion

In the course of investigation in addition to dynamics of population of the dominant Crustacea species, some ecologicalfactors were also monitored, Fig. 1. As can be seen pH values varied slightly, never going over 8,6. Creater variations were experienced with temperature and amount of oxygen dissolved in water. Values for

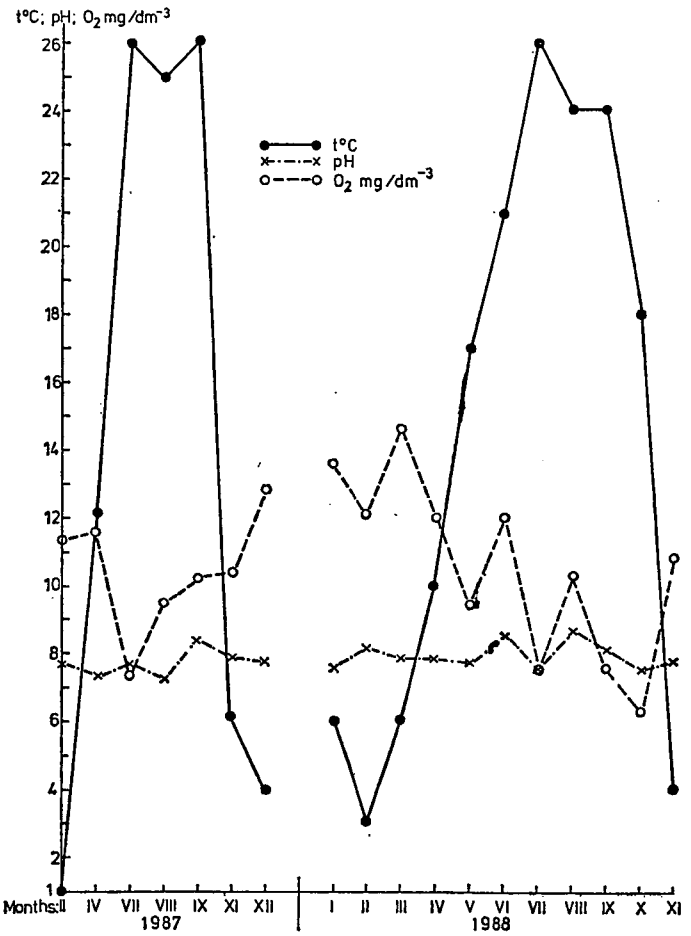

Fig. 1. Some physical and chemical parameters of water in the Dead Tisa near Čurug in the period of investigation

oxygen are rather high, which is quite understandable, keeping in mind the biological productivity of the ecosystem. They were lower when water temperature was higher and vice versa. For the Crustacea as seen in Table 1 during investigation period a total of 19 Cladocera species and 8 Copepoda species were found. So the list of Cladocera species increased compared with our previous investigations (PUJIN and RATAJAC 1988), while the number of Copepoda species remained the same. Quantitave and qualitative composition was different in the years of investiagtion and varied according to season. In 1987 13 Cladocera species and 8 Copepoda species were recorded. In the second year number of Cladocera species increased to 18 and Copepoda species decreased to 6. Species: *A. harpae, L. kirdiii, L. leydigii, M. laticornis, S. mucronata* and *S. vetulus* were not recorded in 1987. A variance in qualitative composition of Copepoda was less expressed in the years of investigations. In the second year of investigation *A. robustus* and *C. strenuus* were not found.

Seasonal variations were also noticable. The largest number of species in both years was in summer, than in autumn and spring, and the least number in winter. The largest number of species was found in summer of 1988, when 14 Cladoceara species and 6 Copepoda species were recorded, while in autumn of the same year 11 Cladocera and 5 Copepoda species were observed. Dominant Cladocera species were: *B. longirostris, Ch. sphaericus, D. cucullata, D. brachyurum* and *S. crystalina.* Thes species had the highest frequency index, Tabl. 1. Some species had considerable frequency index such as: *A. quadrangularis* and *D. cucullata* in 1987, but low population density. In our previous investigations (PUJIN and RATAJAC 1988) when zooplankton was studied in the period from 1983 to 1987 in the Dead Tisa, aforementioned species were dominant along with *D. longispina.* They were present in each year of investigation. It is interested to emphasize the presence of *B. coregoni* species in the Dead Tisa, being a rare element of Cladocera fauna in the fauna of Seriba. The presence of periphytonic species should also be underlined: *A. harpae, Ch. sphaericus, A. excisa, S. crystalina* i *S. vetulus,* as well as species specific for litoral and bentos: *M. laticornis,* and representatives of *Scapholeberis* genus which is quite understandable bearing in mind that this ecosystem is rich in phytoplankton and aquatic macrovegetation. However, plankton species are also present such as: *B. longirostris,* representatives of *Daphnia* and *Ceriodaphnia* genus and *D. brachyurum* from *Cladocera* and *M. leuckarti* and *Th. crassus* from Copepoda. During a warmer part of the year species *D. brachyurum* and *S. crystalina* had higher population density, a rare phenomenon in our waters, and from Copepoda: *M. leuckarti* and *Th. crassus.*

Dominant Copepoda species were: *A. vernalis, C. vicinus, E. gracilis,* and *Th. crassus,* Table. 1. The highest population density was observed in summer. Species *E. serrulatus* and *M. leuckarti* had considerable frequency index, but small number of individual Copepoda in samples. For *E. gracilis* species frequency index was 100, but frequency of domination and order of domination was not so high. as in species *Th. crassus,* which had much higher population density. During all seasons the folowing Cladocera species were present: *B. longirostris, Ch. sphaericus, D. cucullata,* and Copepoda *A. vernalis, C. vicinus, E. serrulatus, E. gracilis* and *Th. crassus.*

Group of authors studied planktons in this ecosystem (KALAFATIĆ et *al.* 1982). They reported 15 Cladocera and 8 Copepoda species. Except a small number of species the same was reported in our investigations.

Similar qualitative composition of Crustacea is observed in the Obed-bara (ŽIVKOVIĆ 1973). This is understandable since there are certain similarities between these ecosystems. Waters are relatively shallow with insignificant motion. The Tisa supplies the Dead Tisa, while the Obed-bara receives its water from the Sava. Area,

Table 1. *Qualitative Composition of the Crustacea groups infestigated in the dead Tisa near Čurug*

Cladocera:	1987							1988						
	W	Sp	Su	A	pF	DF	Dt	W	Sp	Su	A	pF	DF	Dt
Acroperus harpae (BIRD)										×		9.0		
Alona quadrangularis (O. F. M.)		×	×	×	44.4					×	×	27.3		
Alonella excisa Fischer	×		×	×	33.3						×	18.2		
Bosmina cocegoni BIARD			×		22.2					×	×	18.2		
B. longirostris (O. F. M.)	×	×	×	×	77.7	33.3	42.8	×	×	×	×	81.8	45.4	55.5
Ceriodaphnia quadrangula (O. F. M.)			×	×	22.2				×		×	27.3		
Chydorus sphaericus O. F. M.	×	×	×	×	66.6	44.4	66.6	×	×	×	×	81.8	45.4	55.5
Daphnia cucullata SARS	×	×	×	×	77.7			×	×	×	×	72.7	9.0	12.4
D. Longispina O. F. M.		×			11.1				×		×	18.2		
Diaphanosoma brachyurum (LIEVIN)			×	×	44.4	33.3	75.0			×	×	36.4	18.2	50.0
Leptodora kindtii (FOCKE)										×		9.0		
Leydigia leydigii (SCHOEDLER)										×		9.0		
Macrothrix laticornis (Jurine)										×		9.0		
Moina micrura (KURZ) ŠRAMEK—HUŠEK			×		11.1					×	×	27.3		
M. rectirostris (LEYDIG)			×		11.1									
Scapholeberis kingi SARS			×	×	22.2					×		18.2		
S. mucronata (O. F. M.)										×		9.0		
Sida crystalina (O. F. M.)			×		22.2	11.1	50.0			×	×	27.3		
Simocephalus vetulus (O. F. M.)								×				9.0		
Total	19	4	5	12	8			4	5	14	11			
	13							18						

Copepoda:																	
Acanthocyclops robustus (G. O. SARS)			×	×		22.2											
A. vernalis FISCHER		×			×	33.3	11.1	33.3		×	×	×	36.4				
Cyclops strenuus FISCHER		×				11.1											
C. vicinus (ULJANIN)		×	×	×	×	66.6	33.3	50.0	×	×	×		54.5	36.4	66.8		
Eucyclops serrulatus (FISCHER)		×		×	×	33.3			×	×	×	×	63.6				
Eudiaptomus gracilis SARS		×	×	×	×	100	11.1	11.1	×	×	×	×	100.0	9.0	9.0		
Mesocyclops leuckarti (LAUS)			×	×	×	33.3					×	×	36.4				
Thermocyclops crassus (FISCHER)		×	×	×	×	100	55.5	55.5		×	×	×	81.8	72.7	88.9		
Total	8	6	5	6	6				3	5	6	5					
				8							6						

W — Winter; Sp — Spring; Su — Summer; A — Autumn; pF — Frequency index; DF — frequency of domination;
Dt — Order of domination

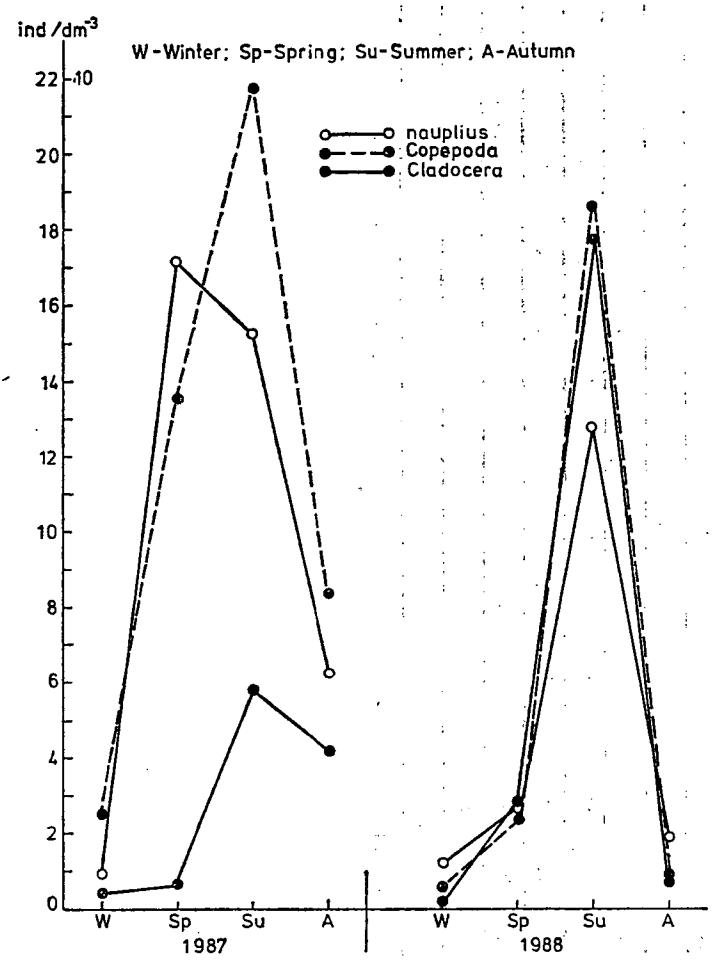

Fig. 2. Quantitative composition of the Crustacea groups investigated in the Dead Tisa near Čurug
Table 1. *Qualitative composition of the Crustacea groups investigated in the Dead Tisa near Čurug*

alongside the river is overgrown with macrovegetation. There was considerable difference in the quantitative composition between the years of investigation. Maximum values for Cladocera and Copepoda in the first year of investigation were obtained in summer and for nauplius stages in spring, Fig. 2. In the second year of investigation maximum values for all three groups were obtained in summer, than in spring and autumn. In addition to other factors this composition was greately affected by the temperature wich varied considerably in spring of that year due to late snow that unexpectedly fell in spring, Fig. 1. The number of Copepoda species in winter months during the first year was two times higher, i.e. 6 and in the second year 3 species. Total numerical values were lower in the second year of investigation. In both years of investigations the highest values were for Copepoda.

Conclusion

In the course of 1987—1988 investigation of the composition and dynamics of Crustacea in the Dead Tisa, near Čurug was performed. In that period a total of 19 Cladocera and 8 Copepoda species was found.

Variatons in the qualitative and quantitative composition was observed between the years of investigation, as well as between particular season. Number of Cladocera species in the first year of investigation was 13, while in the second year it was 18. Number of Copepoda species in 1987 reached 8, while in 1988. it was 6.

Differences were also evident according to seasons. The greatest number of species was found during summer than in autumn and spring, and the least during winter.

In quantitative composition differences both between years of investigation and various seasons were apparent. In the first year of investigation maximum values for Cladocera and Copepoda were obtained during summer and for nauplius stages during spring.In the second year of investigation maximum values for all three groups were in summer months than in spring and autumn. These differences were caused according to my opinion by water decrease in the spring of 1988.

Most dominant species with the highest frequency index, appearing in all seasons were: *B. longirostris, Ch. sphaericus, D. cucullata* from Cladocera and *A. vernalis, C. vicinus, E. serrulatus, E. gracilis* and *Th. crassus* from Copepoda. Species *D. brachyurum* and *S. crystalina* had high order of domination but not high frequency index because they were dominant and had great population density in the warmer period of the year.

Periphytonic species were represented by: *A. harpae, A. excisa, Ch. sphaericus, S. crystalina, S. vetulus* and *E. serrulatus* and bentos and litoral *M. laticornis* along with representatives of *Scapholeberis* genus. From planktonic species the following reperesentatives of genus were present: *Daphnia* and *Ceriodaphnia, B. longirostris, D. brachyurum, L. kindtii, M. micrura,* and *M. leuckarti* and *Th. crassus.*

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A Crustacea populáció domináló fajainak összetétele és dinamikája a Holt-Tiszában

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Kivonat

Az 1987—88-as időszakban a Crustacea populációból 19 Cladocera., ill. 8 Copepoda faj került azonosításra a Holt-Tiszában.

Az első évben 13 Cladocera és 8 Copepoda, a második évben pedig 18 Cladocera és 6 Copepoda fajt azonosítottak. A fajszám intenzitás a nyári időszakban volt kifejezett (12 és 14 Cladocera-., ill. 6 Copepoda faj).

A domináns fajok közül, amelyeknek a legnagyobb „rang dominanciájuk" volt ezek a *B longirostris, Ch. sphaericus, D. brachyurum, S. crystalina, C. vicinus* és *Th. crassus;* viszont nem volt kiemelkedő a gyakoriságuk (DF); a *D. cucullata, E. gracilis* és *E. serrulatus* fajoknak pedig nagyobb. frekvencia indexük volt (pF).

A fizikai-kémiai paraméterek közül a víz hőmérséklete (t °C) mutatott legnagyobb változást. A nyári időszakban 26 °C-t is elérte. A hőmérséklet emelkedésével csökkent az oldott O_2 mennyisége akár 6,8 mg/dm³-re is. A mennyiségi összetétel ugyancsak változó volt.

Az összértékek 1987-ben magasabbak voltak. A nyár folyamán érték el a maximum értékeket a Cladocera és Copepoda fajok (59 és 217 ind/dm³), a Nauplius 171-es indexszel tavasszal volt.

A maximum értékeket mindhárom csoport nyáron érte el (Cladocera 177-, Copepoda 187- és Nauplius 127 ind/dm³).

Состав и динамика доминантных видов Crustacea в Мертвой Тисе

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Резюме

В 1987 г. и 1988 г. среди Crustacea в мертвой Тисе было обнаружено 19 видов Cladocera и 8 видов Copepoda. В 1987 г. было обнаружено 13, а в 1988 г. — 18 видов Cladocera и соответственно 8 и 6 видов Copepoda. Летом число наблюдаемых видов было наиболее выским (12 и 14 видов Cladocera 6 видов Copepoda). Доминантными являлись следующие виды: *B. longirostris, Ch. sphaericus, D. brachyurum, S. crystalina, C. vicinus* и *Th. crassus* для этих видов уровень доминантности (Dt) был самый высокий, в то время как их частота доминантности (DF) не всегда была самой высокой. У следующих видов наблюдался самый высокий частотный индеск (pF): *D. cucullata, E. gracilis, E. serrulatus,* а в то же время более низкий уровень доминантости. Среди химических и физических характеристик самые значительные изменения наблюдали в температуре воды, которая летом достигала до 26 °C. С повышением температуры уменьшалось количество растворенного кислорода до 6,8 мг/дм³. Наблюдались также изменения количественного состава. Общие значения, полученные в 1987 г., превышали соответственные результаты 1988 г. Максимальные значения плотности для Cladocera и Copepoda наблюдали летом (59 и 217 инд/дм³), а для *Nauplius* — весной (171 инд). В 1988 г. для всех трех групп максимум наблюдался летом (Cladocera 177, Copepoda 187 и *Nauplius* 127 инд/дм³).

Sastav i dinamika populacija dominantnih vrsta Crustacea u Mrtvoj Tisi

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Rezime

U ispitivanom periodu 1987—1988. god., u Mrtvoj Tisi, od Crustacea je ukupno konstatovano 19 vrsta Cladocera i 8 vrsta Copepoda. Prve godine je bilo 13, a druge 18 vrsta kladocera i 8 odnosno 6 vrsta kopepoda. Najveci broj vrsta je bio u toku leta, (12 i 14 vrsta kladocera i po 6 vrsta kopepoda). Dominantne vrste su bile: *B. longirostris, Ch. sphaericus, D. brachyurum, S. crystalina, C. vicinus* i *Th. crassus* i imali su najveći rang dominacije (Dt), ali ne i veliku čestoću dominacija (DF), dok su veći indeks frekvence (pF) imale vrste: *D. cucullata, E. gracilis, E. serrulatus* a manji rang dominacije. Od fizičko-hemijskih parametara najviše je varirala t °C vode. U letnjem periodu je iznosila 26 °C. Sa porastom temperature vode opadala je količina rastvorenog kiseonika i do 6,8 mg/dm^3. Kvantitativni sastav je takodje varirao. Ukupne vrednosti su bile veće u 1987. god. Maksimalne vrednosti za kladocera i kopepoda, (59 i 217 ind./dm^{-3}) bile su u toku leta, a za nauplius 171 ind., bile su u prolece. U 1988. god., maksimalne vrednosti za sve tri grupe su bile u leto, (kladocera 177, kopepoda 187 i naupliusa 127 ind./dm^3.)

ZOOGEOGRAPHICAL CONDITIONS OF SNAILS LIVING ON GRASS-ASSOCIATIONS OF TWO HUNGARIAN LOWLAND REGIONS

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Abstract

The Danube—Tisza Midland and the lower Tisza region were compared as regards their loess, sand and saline as well as secondary grass associations. The results were evaluated on the basis of the zoogeographic system of BÁBA (1982).

According to the climatic conditions of the grass-associations their lowlands' character is indicated by the continental fauna circles (Ponto-Pannonian, East-West-Siberian, Caspian-Sarmatian). Due to the closure sward and moistening the ratio of certain fauna circles increases. The lower Tisza region — having more diversified soil conditions — is richer in snails prevealing the continenta fauna elements. The fauna circle differentiating the Danube—Tisza Midland is the Quercion frainetto

Introduction

As a consequence of the agriculture, melioration and draining work, beginning from the last century the natural grass associations — which formerly covered large areas of the Great Hungarian Plain — were strongly reduced or replaced by secondary plant populations. Malacological and zoogeographical investigations of these areas have become a pressing task.

Among the several plant associations of the Hungarian Plain the Loess heath-grass, as well as sedge and moor grass associations were heavily supressed by the agricultural cultivation and draining, at present they do exist only in fragments. The sandy wastes were eliminated, too. Spreading of secondary types of saline plantage shows an increasing tendence.

The aim of this study is to show the zoogeographical and malacological differences of the plant associations derived from the four grass associations mentioned above.

Materials and Methods

The samples were collected in Bugac, Csévharaszt, Kunbaracs, Ásotthalom (Danube—Tisza Midland) and at Alpár and Szeged (lower Tisza region) as well as in Nagytatársánc between 1966 and 1987. The $10 \times 25 \times 25$ cm square method was used in 30 places. For the zoogeographical analysis also the data of my earlier observations in Alpár and Szeged area (BÁBA 1969, 1976, 1985, 1987) as well as the

data of Hornung (1986) on the plant associations *Molinio-Salicetum rosmarinifoliae* of the soil trap in Bugac were used.

The zoogeographical analysis was on the basis of the BÁBA (1982) zoogeographic system, were continental and subatlantic fauna circle groups can be distinguished according to the climatic character of the fauna circles' spreading centers. The climatic type of the fauna circles could be characterized by linear regression functions at a significance level of P=0,1%.

The differences between the zoogeographical fauna circles of grass associations of the two examined regions were established by Chi^2 test.

Results and Discussion

1. Plant associations

The nomenclature of the examined plant associations was given according to Soó (1964) system Ordo and association, with the indication of their succession relations. Table 1 shows the distribution of snails collected from different plant associations.

Loess vegetation: Festucetalia valesiacae BR. BL. et TX. 1943; 1. *Salvio-Festucetum sulcatae tibiscense* ZÓLYOMI 1958 Lőszpusztarét (BÁBA 1976). It exists today in fragments only. On the influence of the antropogenous effect grass-lands often develop on the slopes of dams: Arrhenatheretalia PAWLOWSKI 1928; 2. *Pastinaco-Arrhenatheretum elatioris* (MÁTHÉ, KOVÁCS 1960) SOÓ 1971.

Sand vegetation: Festucetalia vaginatae SOÓ 1957.; 3. *Brometum tectorum* (KERN 1863) BOJKÓ, SOÓ 1934., one year brome-grass (BÁBA 1969, 1985, 1987) includes the *cynodontetosum* BORHIDI 1958 and *Juniperus communis* subassociation and facies. By its closure develops the 4. *Festucetum vaginatae darnubiale* SOÓ 1929 calciphilous sandy heath-grass. The list of species includes the normale KÁRPÁTI 1954. *fumanetosu* (MAGYAR 1933) SOÓ 1939, stipetosum capillatae (MAGYAR 1933) SOÓ 1959, *salicetosum rosmarinifoliae* (MAGYAR 1933) SOÓ 1959 investigations done in subassociations.

Festucetalia valesiacae BR. BL. et TX. 1943; 5. *Potentillo-Festucetum pseudovinae danubiale* BODROGKÖZY 1959 sandy grazing land. The *Astragalo-Festucetum sulcatae danubiale* (SOÓ 1939, ZÓLYOMI 1958), grazing was not investigated by us a secondary association which develops on sandy chernozem soil after, Alpár 1987., Bugac 1969., Molinetalia W. KOCH 1926; 6. *Molinio-Salicetum rosmarinifoliae* (SOÓ 1933) 1961 sandhill moor-grass. (Hornung 1986), Ásotthalom 1988. It constitutes a transitim to the moor-grasses *Molinetum coeruleae* (Allorge 1922) W. KOCH 1926, and to the *Festucetum vaginatae* (SOÓ 1964).

Saline grass associations: Puccinetalia SOÓ 1957; 7. *Agrostio-Caricetum distantis hungaricum* (RAPAICS 1927) BODROGKÖZY 1960. Saline sedge grass Alpár 1987. It turns into saline speargrass 8. *Agrostio-Alopecuretum pratensis* SOÓ 1933 ALPÁR 1987. Its extremely dry variant is *Camphorosmetum annuae* (RAPAICS 1916) SOÓ 1933.

As a consequence of the extreme conditions of blind saline plantage, no snails were found on it in the vicinity of Alpár and Szeged (Dorozsma, Fehértó, Sándorfalva). In the blind saline plantage on more humid and higher reliefs forms 9. *Lepidio-Puccinellietum limosae* (TOPA 1939) BODROGKÖZY 1958 saline plantage.

Weeds: At the base of dams Plantaginetalia majoris TX. 1950: *Lolio-Plantagi-*

Table 1. *Species and numbers of individuals in the plant-associations studied*

Species and Fauna circles	Number of species								
	Loess assotiations		Sand associations				Saline associations		
	1	2	3	4	5	6	7	8	9
1.1. *Pupilla muscorum* (L. 1758)	89	—	—	16	56	4	8	—	4
Perforatella rubiginosa (A. SCHMIDT 1853)	—	—	—	—	—	2	—	—	—
1.2. *Succinea oblonga* (DRAP. 1801)	—	1	—	—	—	5	—	41	21
Vertigo pygmaea (DRAP. 1801)	—	—	—	—	—	4	—	—	—
1.3. *Deroceras agreste* (L. 1758)	2	—	—	—	—	—	—	—	—
1.4. *Vallonia pulchella* (O. F. MÜLLER 1774)	44	3	—	5	—	3	2	—	—
Vallonia costata (O. F. MÜLLER 1774)	110	—	5	4	—	—	—	—	—
Vitrina pellucida (O. F. MÜLLER 1774)	—	—	—	3	—	—	—	—	—
Cochlicopa lubrica (O. F. MÜLLER 1774)	2	9	—	—	—	—	—	—	—
Zonitoides nitidus (O. F. MÜLLER 1774)	—	2	—	—	—	—	—	—	—
Euconulus falvius (O. F. MÜLLER 1774)	7	—	—	—	—	—	—	—	—
2.2. *Cochlicopa lubricella* (PORRO 1837)	—	—	—	—	—	3	—	—	—
3. *Enomphalia strigella* (DRAP. 1801)	1	—	—	—	—	—	—	—	—
Copaca vindobonensis (FER. 1821)	—	—	23	16	—	1	—	—	—
5.3. *Helicella obvia* (MENKE 1828)	—	—	—	1	748	—	26	—	—
Helicopsis striata (O. F. MÜLLER 1774)	—	—	26	74	46	2	21	—	—
Helix pomatia (L. 1758)	—	1	4	—	—	—	—	—	—
5.2.1. *Granaria frumentum* (DRAP. 1801)	—	—	—	19	16	—	—	—	—
8. *Truncatellina cylindrica* (FR. 1807)	3	—	14	19	—	13	—	—	—
Chondrula tridens (O. F. MÜLLER 1774)	17	—	—	30	3	50	—	—	—
Succinea elegans (RISSO 1826)	—	2	—	—	—	—	—	—	—
Monacha carthusiana (O. F. MÜLLER 1774)	5	2	—	—	—	25	4	8	—
Number of indivuals (1670)	280	20	72	187	869	112	61	49	25
Number of cases (24)	1	1	3	6	6	2	1	2	1

Plant-assotiations

1. *Salvio-Festucetum*
2. *Pastinaco-Arrhenatheretum*
3. *Brometum-tectorum*
4. *Festucetum-vaginatae*
5. *Potentillo-Festucetum*
6. *Molinio-Salicetum*
7. *Agrostio-Caricetum*
8. *Agrostio-Alopecuretum*
9. *Lepidio-Puccinellietum*

netum majoris (LINKOLA 1921) BERGER 1930 rye-grass plant association did not contain snails at Szeged, 1987.

As regards the snail occurrence 9 of the 11 examined plant associations proved to be suitable for zoogeographical studies.

2. Zoogeographical differences of snail associations

In the examined plant associations 1670 living snails of 22 species were identified. The plant associations significantly differ in their zoogeographical and cenological composition (Table 1, 2).

The loess association *Salvio-Festucetum* is characterized by the predominance of East-Siberian (1.1), Holarctic (1.4) fauna circles *(Pupilla muscorum, Vallonia pulchella, V. costata)*. Caspian-Sarmatian (1.3) and Holomediterranean *Chondrula tridens* (8) are coloruing elements. 2. *Pastinaco-Arrhenatherum* is characterized by the predominance of Holarctic elements (1.4) *(Cochlicopa lubrica);* the colouring elements change, an increase of the ratio of Ponto-Pannonian as well as Holomediterranean ones (8) is observed. In the common fauna circles a change of species occurs. Sand association: 3. In *Brometum tectorum* the fauna circles 5.3. Ponto-Pannonian *(Helicopsis striata)*, 3. Caspian-Sarmatian *(Cepaea vindobonensis)* are characteristic. The 8. Holo-Mediterranean *Truncatellina cylindrica* is a colouring element. In the 4. *Festucetum vaginatae* — which develops after sward closure — the number of Ponto-Pannonian and Holo-mediterranean fauna elements increases. A colouring element here is 1.1. East-Siberian *(Pupilla muscorum)*.

The dominant fauna circles in *Pontentillo-Festucetum* (5) are the East-Siberian *(Pupilla muscorum)* and the 5.3. Ponto-Pannian *(Helicella obvia)*. The 5.2. Quercion frainetto *(Granaria frumentum)* is a colouring factor.

Moor-grasses: 6. *Molinio-Salicetum.* The Holomediterranean *Chondrula tridens, Monacha carthusiana* are dominant fauna circles. The West-Siberian Vertigopygmaea and the Turcestanian *Cochlicopa lubricella* are colouring elements at the Danube—Tisza Midland, the latter being a differentiating fauna element in comparison with other plant associations.

Saline grass associations: the dominant fauna circle of *Agrostio-Caricetum* (7) is the Ponto-Pannonian one (condominants are *Helicella obvia, Helicopsis striata)*. The East-Siberian and Holomediterranean *(Monacha carthusiana)* fauna circles are colouring ones. In the humid 8. *Agrostio-Alopecuretum* the West-Siberian *(Succinea oblonga)* fauna circle is dominant, the Holomediterranean *Monacha carthusiana* is a colouring species.

As a consequence of the alcalization developed the *Lepidio-Puccinellietum* (9) where Siberian-Asiatic elements are dominant. The West-Siberian *(Succinea oblonga)* fauna circle is dominant coloured by the East-Siberian *Pupilla muscorum.*

3. Common and differentiating characteristics of grass associations

A decisive part of the fauna elements (90.49%) is continental independently from the site of the samples, collected from original or secondary plant associations. Sub-Atlantic elements represent 9.49%. The continental elements are derived from the following fauna circles: Siberian-Asiatic (1,1, 1.2., 1.3., 1.4.), Turcestanian (2.2),

Caspian-Sarmatian (3), Ponto-Pannonian (5.3). The Sub-Atlantic fauna elements belong to the Holomediterranean (8) and — with a few individuals — to the fauna circles Quercion frainetto (5.2.1).

From the possible 18 fauna circles (BÁBA 1982) only 9 occurred on the studied grass associations, what is due to the warm and dry climatic conditions. The examined grass associations developed historically in the climatic steppe epoch and preborealist: the loess and sand grasses, as well as saline grasses in the borealis. Their botanical character was given by the dominance of Pontian and other continental species (SIMON 1979).

Their survival was promoted by the climatic conditions of the Great Hungarian Plain (BORHIDI 1966).

JUHÁSZ (1974) showed that the high proportion of continental fauna elements can be supported also by the recent microclimatic conditions. As shown the air temperature at the soil surface presents a higher amplitude on saline grass meadow, top of dunes and on deeper regions than at 150 cm above the soil level. The humid loam soils use the received energy partly for transpiration, thus they are colder than drier sandy soils. Therefore the soil surface is of continental microclimate character.

Recent plant geographical studies (JAKUCS 1981) also confirmed the microclimatic, continental character of grass associations concluded from the presence of snail communities. From the point of view of plant geography loess meadows are described as of continental Eurasiatic character, sandy meadows as Continental-Pontean and Pontean-Mediterranean.

The single plantal succession circles in different grass associations are differentiated also by the presence or absence of certain fauna circles.

Loess meadows are characterized mostly by East-Siberian, Holoarctic fauna circles (Table 2) with a small Holomediterranean colouring effect. On sandy meadows Caspian-Sarmatian and Ponto-Pannonian fauna circles are dominant and also Quercion frainetto appears.

Table 2. *Percentile distribution of fauna-circles in different plant-associations*

Fauna circles	loess associations		sand associations				saline associations		
	1	2	3	4	5	6	7	8	9
1. Sibirian-Asian	90,7	75,0	6,94	14,97	6,44	16,07	16,38	83,67	100
1.1. East-Sibirian	31,78	5,0	—	8,55	6,44	5,35	13,11	—	16,0
1.2. West-Sibirian	—	—	—	—	—	8,03	—	83,67	84,0
1.3. Euro-Sibirian	0,71	—	—	—	—	—	—	—	—
1.4. Holarctic	58,21	70,0	6,94	6,41	—	2,67	3,27	—	—
2.2. Turkestanian	—	—	—	—	—	2,67	—	—	—
3. Caspian-Sarmatian	0,35	—	31,94	8,55	—	0,89	—	—	—
5.3. Ponto-Pannonian	—	5,0	41,66	40,10	91,36	1,78	77,04	—	—
5.21 Quercion frainetto	—	—	—	10,16	1,84	—	—	—	—
8. Holomediterranean	8,92	20,0	19,44	26,20	0,34	78,57	6,55	16,32	—
Continental	91,05	80,0	80,55	63,63	97,81	21.42	93,42	83,67	100
Subatlantic	8,92	20,0	19,44	36,36	2,18	78,57	6,55	16,32	—
	99,97	100,0	99,99	99,99	99,99	99,97	99,97	99,99	100
Number of species		7	5	10	5	11	5	2	2

A differentiating element of Holomediterranean fauna circle is *Truncatellina cylindrica* contrary to the loess and saline grass formations. Moor-grass meadows are characterized by the dominance of Holomediterranean fauna circles. Ponto-Pannonian and West-Siberian as well as increasing continental fauna circles dominate the saline grass formations.

4. Differences between the two investigated regions

Table 3 shows the zoogeographical differences of the grass associations investigated at the lower Tisza region and Danube—Tisza Midland. On the basis of the Chi^2 analysis fauna elements significantly differed in the two examined regions. This difference was supported also by the results of BÁBA (1983) who has investigated the forests of these regions.

ANDÓ (1969) emphasized the water permeability of subsoils as the most important microclimatic factor. In contrary to the water closing layer of the right bank of Tisza region, the water permeable layers of the left bank as well as those of the Danuba—Tisza Midland result in a drier, warmer microclimate. This is manifested by the differences in number of species and individuals of snails living in the lower Tisza regions' and Danube—Tisza Midlands' grass associations, as well as in those of fauna circles.

A further difference between the two regions is the higher species number in the lower Tisza region and the richness of Siberian-Asiatic fauna circles in species and individuals. At the Danube—Tisza Midland the presence of fauna circle Ponto-Mediterranean Quercion frainetto is of differentiating character, on drier sandy soils the deficiency of Euro-Siberian slugs as well as the relatively higher number of

Table 3. *Zoogeographical differences in the grass-associations of the lower-Tisza Region and of the Danube—Tisza Midland*

Fauna circles	Lower-Tisza Region number of species	of individuals	Danube—Tisza Midland number of species	of individuals
Sibirian-Asian	8	353	5	57
1.1 East-Sibirian	1	147	2	28
1.2 West-Sibirian	1	77	1	9
1.3 Euro-Sibirian	1	2	—	—
1.4 Holarctic	5	77	3	20
2.2 Turkestanian	—	—	1	3
3. Caspian-Sarmation	1	1	1	40
5.3 Ponto-Pannonian	3	151	3	797
5. Ponto-Mediterranean	—	—	1	35
5.21 Quercion frainetto	—	—	1	35
8. Holomediterranean	4	40	3	153
Σ Continental	12	505	11	897
Σ Subatlantic	4	40	4	188
Number of species	16	545	15	1085
Number of cases	10		13	

individuals of subatlantic fauna elements have the same function. Further investigations should promote the deficiency of Quercion frainetto and Turcestian fauna circle in grasses of the lower Tisza region and the absence of Eurosiberian fauna circle in the Danube—Tisza Midlands' grasses.

The separation of the two regions has started already in the Pleistocene due to the differences manifesting in the climatic character induced by the pedological and the water permeable soil layers. Similar differences were shown between the two regions by HORVÁTH, HORVÁTH and ANTALFY in 1954 and between 1962—1972, in boring samples from Felsőszentiván and from Szentes to Baja, during examination of the geological layers from Mindel to Würm III.

The layer structure of the two regions differ from each other in the mutual deficiency of 12 species starting from the Riss I. glaciale epoch. In the steppe epoch 6—17 species are to be found with East-, West-Siberian and Holoarctic fauna elements, which exist also today.

This early differentiation means that, due to pedological and climatic causes already in the Pleistocene developed those zoological differences which characterize the natural geographical small- and Midlands' regions existing now.

The landscape character of grass associations at the plain are formed by continental Ponto-Pannonian, Caspian-Sarmatian, East- and West-Siberian fauna elements. The continental character of grass associations is related since their formation to the semiaridous macroclimatic conditions of the Great Hungarian Plain, as well as to the microclimatic conditions assured by the presence or absence of water permeable soils and subsoil layers.

On the basis of the zoogeographical analysis of snail communities the relation between continental and subatlantic fauna circles corresponds to the results of plant geographical investigations.

Due to the moistening the West-Siberian elements in the saline grass associations become predominant. As a consequence of the alcalization the species number decreases during the plantal succession.

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Két alföldi tájegység gyeptársulásain élő csigák állatföldrajzi viszonyai

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Kivonat

A szerző a Duna—Tisza köz és a tiszai-Alföld két tájegységét hasonlította össze lösz, homoki, sziki és másodlagos gyeptársulásaik alapján. A feldolgozás Bába (1982) állatföldrajzi rendszere alapján történt.

A gyeptársulások klímajellegének megfelelően a pusztai jelleget kontinentális faunakörök indikálják (ponto-pannon, kelet-nyugat-szibériai, kaspi-szarmata). A gyepzáródással és nedvesedéssel más-más faunakörök részaránya nő. A két tájegység közül a változatosabb talajtani adottságú tiszai-Alföld gazdagabb csigákban, a kontinentális fauna elemek túlsúlyával. A Duna—Tisza köze differenciáló faunaköre a Quercion frainetto.

Зоогеографическое сравнение улиток, обитающих в травянистых сообществах двух областей альфёльдской степи

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Резюме

Автор сравнивает две области, расположенные в междуречьи Дуная и Тисы и в тисайской Альфёльдской степи, на основании лёссовых, песчаных, солончаковых и вторичных травянистых сообществ. В основу обработки результатов положена зоогеографическая система Баба (1982).

В соответствии с климатическими особенностями травянистых сообществ, их степной характер отражают фаунистические комплексы (понто-паннонийский, восточно-западносибирский, каспийско-сарматский). С закрытием и увлажнением дерна изменяется соотно-

шение преобладающих фаунистических комплексов. Из исследуемых областей тисайская Альфёлдская степь, обладающая большим разнообразием почвенных условий, богаче улитками, среди которых преобладают элементы континентальной фауны. Характерным фаунистическим комплексом междуречья Дуная и Тисы является Quercion frainetto.

Zoogeografski odnosi između dve nizinske oblasti na temelju pužne faune

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Abstrakt

Autor je usporedio dvije oblasti: područje između Dunava i Tise i Nizinu Tise na temelju lesne-, peščane-, slatine- i sekundarne ledične zajednice. Tema je bila obrađena sa BÁBA (1982) zoogeografijskom sistematikom.

Sa odgovarajućim klimatičnim osobinama ovih ledičnih zajednica indikatorna zajednica puža su kontinentalnog karaktera (ponto-panonskog, I—Z sibirični, kaspi-sarmatski).

Sa „zatvaranjem trave" i sa povećanjem vlažnoće menjaju se srazmere zajednice puža.

Sa prevagom kontinentalnog karaktera Nizina Tise ima bogatiji svet puža, to dolazi od mnogo raznovrsnijeg tla.

Diferncijalna zajednica područje Dunava i Tise je Quercion frainetto.

CHANGES IN THE FISH POPULATION OF THE INTERMITTENTLY CLOSED TISZA-DEAD-ARM

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Abstract

The author carries out a comparative study of the fish population of the river Tisza and the dead Tisza at Lakitelek, and follows its seasonal changes since 1982. In addition to the investigations of the effect of ecological factors on the fish stock, antropogen effects have been studied as well.

Annual changes in the fish species of the dead-arm have been followed. Fauna-list was compiled, indicating species occurrence and disappearance from the dead-arm. Comparative measurements have been carried out on fish progeny hatched in the Tisza and the dead Tisza in Alpári-valley in the course of the years.

Comparative nutritional studies of different fish species in the Tisza and the dead arm at Lakitelek have been carried out.

The influence of pollution in the Tisza and the dead arm on the pisces fauna is discussed

Introduction

Investigations of the pisces fauna have been carried out under the auspices of the Hungarian Academy of Sciences in the framework of the Tisza-Research Working Group. The measurements and observations performed year by year provided information on the conditions of reproduction and nutrition of different fish species, effect of pollution, appearance of protected species and ecological relations of the river Tisza and the dead-arms. By comparison with the data obtained in other countries information is gained on the relation of the fresh-water pisces fauna in Hungary and fish species in the Danube-valley.

The literature data on the relation between the dead-arms and the Tisza are scarce (FERENCZ 1965, MARIÁN 1971, FARKAS 1976, 1981). The authors listed above studied the dead-arms at Mártély and Körtvélyes, however, a comprehensive review of the literature data on the population dynamics of fish species from the dead-arm at Lakitelek is not available.

Materials and Methods

Samples have been collected at three sampling sites selected in the northern, southern and middle stretch of the dead arm between middle May and beginning of November every 14 days, altogether on 12 occasions. Fine-mesh net (4 mm×4 mm), progeny net (15 mm×15 mm) and gill-nets (28 mm×28 mm, 35 mm×35 mm, 48 mm×48 mm) were used. The broad mesh range helped

in overcoming the negative selection. On every single occasion the full breadth of a 75 m stretch of the dead-arm was investigated. In the autumn the author participated in the fishing out of the whole dead-arm with trailnets.

The body mass of the fish specimens caught by the author was measured and their age determined according to the year marks on scales.

Fish specimens from the Tisza were collected with the help of fishermen in the reach of 180—204th km. Fauna list was compiled on the basis of fish species caught, and subsequently systematized in a table.

Results and Discussions

Description and Ichtyological Data on the Dead-Arm at Lakitelek

The dead-arm is located on the right bank side of the river Tisza. It is an intermittently closed dead-arm flooded by the Tisza when the water-level reaches 7 m. Usually, this takes place in April—May and coincides with the spawning-season.

The dead-arm is located above Csongrád in the reach of 262—266th km of the river Tisza. It is a U-shaped, appr. 7 km long, 150 m wide, 0,5—4 m deep area, covered by rich aquatic vegetation, with fish species characteristic for the bream regions. The depth of water in the dead-arm increases evenly from the banks inwards. In the middle the depth reaches on the average 1,5 m. In the transparent, easily warming up water the hatched fish progeny can be clearly seen. The rich aquatic vegetation in the dead-arm provides favourable conditions for roe laying. The muddy riverside stretches, covered by vegetation ensure rich nutrient sources for raising progeny.

The Dead-Arm Vegetation

The vegetation of the dead-arm surroundings and its water is extremely rich. The following plant communities are observed:

Alopecuretum geniculati
Rorippo sylvestri — Agrostetum stoloniferae
Trifolio fragiferi — Agrostetum stoloniferae
Lolio — Potentilletum anserinae
Lolio — Alopecuretum pratensis
Rorippo austriacae — Agropyretum
Lolio — Festucetum pseudovinae

In the middle of the Tisza-valley on an area of 400 ha 24 subgroups belonging to 8 hydroecological categories are observed (Bodrogközy 1985).

The following species occur on the banks and in the water of the dead-arm:
Phragmites australis, Lythrum salicaria,
Lythrum virgatum, Potamogeton sp., *Trapa natans,*
Carici-Typhoidetum, Caricetum gracilis, Nymphaea alba.

Zooplankton Organisms of the Dead Tisza

The seasonal changes of the dead Tisza zooplankton show two distinct maxima in the course of the year — in May: 60 000 ind/10 l. and September: 48 000 ind/10 l.

In summer dominate alpha-mesosaprobic zooplankton organisms (GÁL 1986):

Entomostraca

Cladocera

Acroperus harpae B.
Alonera excisa F.
Bosmina longirostris M.
Daphnia longispina M.
Daphnia magna S.

Ostracoda

Cyclocypris ovum J.
Cypria ophthalmica J.
Cypris pubera M.

Copepoda

Acanthocyclops vernalis F.
Eucyclops serrulatus F.
Macrocyclops albidus J.
Metacyclops gracilis L.

Rotatoria

Anureopsis fissa G.
Brachionus angularis G.
Brachionus budapestinensis D.
Brachionus calyciflorus W.
Colurella colurus E.
Keratella cochlearis G.

Table 1. *Relative Abundance of the Fish Species Occurring in the River Tisza and the Dead Tisza at Lakitelek*

		Dead-arm	Tisza
Esociadae	*Esox lucius* L.	+++	++
Cyprinidae:	*Rutilus rutilus* L.	++++	+++
	Leuciscus cephalus L.	+	+
	Leuciscus idus L.	++	++
	Scardinius erythrophthalmus L.	++	+
	Aspius aspius L.	+	++
	Tinca tinca L.	+++	+
	Gobio gobio L.	+	+
	Alburnus alburnus L.	+++	+++
	Blicca bjoerkna L.	+++	++
	Abramis brama L.	+++	+++
	Abramis ballerus L.	+++	++
	Pelecus cultratus L.	+	++
	Rhoedeus sericeus amarus B.	+++	++
	Carasius carasius L.	++++	+
	Carasius auratus gibelio B.	+++	+
	Cyprinus carpio m. *hung.* H.	+++	++
	Cyprinus carpio m. *acuminatus* H.	+++	+
	Hypophthalmichthys molitrix V.	++	+
	Ctenopharyngodon idella V.	++	+
Siluridae:	*Silurus glanis* L.	+	+++
Amiuridae:	*Amiurus nebulosus* L.	+	+
Anguillidae:	*Anguilla anguilla* L.	+	+
Centrarhidae:	*Lepomis gibbosus* L.	+++	++
Perciadae:	*Stizostedion lucioperca* L.	++	++
	Stizostedion volgensis G.	+	+
	Perca fluviatilis L.	++++	++++
	Gymnocephalus cernua L.	++++	++++
	Gymnocephalus schraetzer L.	++	++

From 1000 specimens caught:

+	— rare occurrence	0— 15 specimens
++	— less rare occurrence	15— 50 specimens
+++	— frequent occurrence	50—150 specimens
++++	— very frequent occurrence	more than 150 specimens

Table 2

	Number of studied specimens		Average body mass of specimens							
			one-year-old g		two-year-old g		three-year-old g		four-year-old g	
	T	D	T	D	T	D	T	D	T	D
Esox lucius L.	40	49	180	207	535	620	1050	1220	1650	2100
Aspius aspius L.	30	17	135	130	180	220	800	920	1120	1320
Tinca tinca L.	14	44	—	12	—	78	120	150	170	250
Cyprinus c. m. *hungaricus* H.	44	34	35	37	140	159	500	650	740	850
Cyprinus c. m. *acuminatus* H.	52	42	67	67	230	250	570	670	790	1200
Ctenopharyngodon idella V.	19	22	—	88	300	380	1000	1200	1451	1952
Hypophthalmichthys molitrix V.	32	42	60	66	500	560	800	1050	1200	1810
Silurus glanis L.	34	17	120	120	420	452	1202	1304	1852	2200
Stizostedion lucioperca L.	38	16	50	50	200	250	372	454	524	654

T: Number, resp. average body mass of specimens caught from the Tisza
D: Number, resp. average body mass of specimens caught from the dead-arm at Lakitelek

Phytoplankton Organisms of the Dead Tisza

The seasonal changes of the dead Tisza phytoplankton show yearly two maxima as well. The first — in February, group of *Synura uvella*, and the second — in June, groups of Pyrrhophyta and Euglenophyta (*Trachelomonas volvocinopsis, Chroomonas acuta, Cryptomonas erosa* species). In June the area of macrovegetation reaches 50%, in which the mosaically distributed *Nymphaea alba, Nuphar lutea, Trapa natans* form an uninterrupted surface, except in the middle stretch of the dead-arm (DOBLER—KOVÁCS 1984). Young specimens of different Cyprinida species: *Alburnus alburnus* L., *Rutilus rutilus* L., *Abramis brama* L., *Tinca tinca* L., *Abramis ballerus*, find favourable conditions on the plant stems and roots.

Pisces Fauna of the Dead-Arm

The number of individuals and species composition of the fish population in the dead-arm is determined by the following three factors:

a) periodical floods
b) oxygen depletion developing in summer (July, August)
c) fish introduction into the dead-arm

Due to the spring rise of the Tisza, when the waterlevel exceeds 7 m, the dead-arm is being stocked up with fish species characteristic for the river. Fish appearing in the dead-arm find there favourable conditions up till July—August, when the temperature of its water reaches 28—29 °C. Oxygen depletion developing in the warm water causes significant plankton destruction, methane and hydrogen sulphid are released, and as a consequence fish destruction occurs.

If after the autumn fishing out, too much fish remains in the dead-arm, as for example was the case in the winter of 1986—87, the long-lasting ice cover causes fish destruction as well. The formation of fish population is influenced by the antropogen effect as well. Fishermen regularly introduce *Ctenopharyngodon idella* V., *Hypophthalmichthys molitrix* V. specimens into the dead-arm. The body mass of specimens belonging to these species in some cases exceeds 20 kg (Table 2).

Amiurus nebulosus L. disappeared from the dead-arms of Átka, Körtvélyes, Mártély already 6 years ago. In the dead Tisza it occurs at present quite frequently. This is valid for Tinca tinca L. specimens as well. Striking is the mass appearance of fish progeny in the shallow water of the dead-arm. The rich vegetation is a suitable hiding place for fish progeny, especially for the specimens of the Cyprinida family. The vegetation provides hiding and nutrition for the lower shell-fishes, larvae, worms, which serve as immediate food for fish.

Especially striking is the fast growth of Esox lucius L. The body mass of pikes from the dead-arm exceeds that of the specimens caught from the river Tisza on the average by 15—17% (Table 3).

Table 3. *Comparison of the length and body mass of 1—4-year-old Esox lucius L. caught at Tiszafüred, Dead Tisza at Lakitelek and in the river Tisza in the reach between the 180th and 204th km*

Esox lucius L.	Tiszafüred (HARKA, 1983)		The Dead Tisza at Lakitelek		The River Tisza in the reach of 180—204th km	
Year	body mass g	length mm	body mass g	lenght mm	body mass g	lenght mm
1	182	293	207	297	180	290
2	542	423	620	432	535	419
3	1076	533	1220	547	1050	524
4	1724	625	2100	641	1650	612

Avi- and Mammalian Fauna Related to the Fish Population in the River Tisza and the Dead Tisza at Lakitelek

Aquatic birds and mammals find favourable life conditions in the dead-arm region. *Egretta alba* L., *Egretta garzetta* L., *Ardea cinerea* L., *Ciconia ciconia* L., *Ciconia nigra* L., *Platalea leucorodia* L., *Anas platyrrynchos* L., *Nycticorax nycticorax* L., *Pandion haliaëtus* L., *Fulica atra* L., *Lutra lutra* L. and *Ondatra zibethica* L. (CSIZMAZIA 1976).

Changes in Fish Population in the River Tisza

In summer the depth of the reach studied measures on the average 5 m. However, at the bridge in Algyő and at Ludvár port in Hódmezővásárhely it reaches even 15—20 m. Several factors influence the number of individuals and species of the pisces fauna:

1. Seasonal changes (fish migration and search for spawning places start during the spring flood).
2. Occasional pollution causes a partial destruction of the pisces fauna
3. Decisive are the success of spawning and withdrawal of the hatched progeny from the flood plain.
4. Intensity of fishing, the way of fishing out of the fish-nurseries (dead-arms, inflows).

As far as the live river is concerned, as an indication of the problems arising the more and more seldom occurrence of sturgeon, silurus and pike-perch should be mentioned, which has been frequent only a few years ago (HARKA 1980). The reason for this is to be sought in the increased pollution of the river, in the inflow of the sewage- and waste-water of the town of Szolnok, as well as in the more frequent and deeper pollution in the Bodrog and Körös rivers (e.g. in the autumn of 1986, in March, 1987 and September, 1987).

As shown in Fig 4. a decrease in occurrence of *Silurus glanis* L., *Aspius aspius* L., *Stirostedion lucioperca* L., *Anguilla anguilla* L., *Acipenser ruthenus* L. has been observed.

Table 4. *Fish caught by the Tisza Fishing Cooperative in kg/year between 1984 and 1987*

Fish species	1984	1985	1986	1987	Total:
Cyprinus carpio L.	14 330	13 720	12 940	12 640	53 640
Ctenopharingodon idella V.	2 030	1 200	1 070	1 010	5 330
Hypophthalmichthys molitrix V.	20 210	11 940	15 260	12 030	71 400
Stizostedion lucioperca L.	3 420	2 800	3 040	2 570	11 840
Silurus glanis L.	23 090	31 460	11 350	12 750	18 660
Anguilla anguilla L.	60	30	60	20	190
Aspius aspius L.	110	—	—	—	110
Acipenser ruthenus L.	5 960	2 670	14 380	8 980	31 990
Barbus barbus L.	1 480	970	1 990	2 300	6 750
Amiuridae	48 000	64 670	55 910	87 990	256 600
Amiurus nebulosus L.	—	—	70	430	500
Carassius auratus gibelio B.	2 460	4 330	5 980	7 780	20 560
Esox lucius L.	2 300	10 660	5 710	3 000	21 680
Total:	123 490	156 440	127 820	151 540	559 300

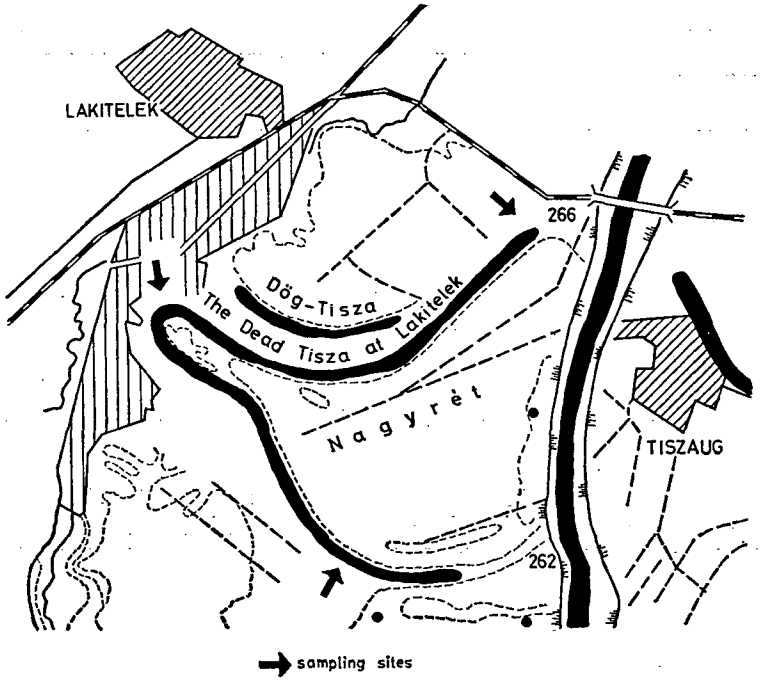

Fig. 1. The Dead Tisza at Lakitelek

A rise in abundance of *Carasius auratus gibelio* B. and of different bream species has been observed.

The decrease in abundance of the commercially important fish species (mainly carnivorous species) in Tisza leads to the conclusion that it is worth considering here the introduction of fishing and angling closed season in the spring months, similar to that valid for the Lake Balaton, in order to protect the indigenous pisces fauna of Hungary. The regulations valid at present stick to the calendar date, and do not take into consideration the actual spawning period which is a function of the weather conditions.

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A Tisza élővízi időszakosan zárt holtágának halállomány változásai

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Kivonat

A szerző az élő Tisza és a Lakiteleki Holt-Tisza halállományának összehasonlító vizsgálatát és annak szezonális változásait 1982-től vizsgálja.

Vizsgálatait a halállományt ért ökológiai hatáson túl az antropogén hatások vonatkozásában is kiterjeszti.

Nyomon követi a holtág halfajainak változását évenként. Faunalistát állít fel és jelzi a megjelenő és a holtágból eltűnő halfajokat. Összehasonlító méréseket végez a Tisza, valamint az Alpári-medence holtágában az évek alatt kelt halivadékokból.

Vizsgálja az egyes halfajok táplálékfogyasztását, összehasonlítva ezt a Tisza és a Lakiteleki-holtág vonatkozásában.

Kitér a holtág és az élő Tisza szennyezéseire és annak a halfaunát ért hatásaira is.

Изменения популяции рыб в периодически закрытом мертвом рукаве Тисы

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Резюме

С 1982 г. проводятся регулярные сравнительные исследования популяций рыб в Тисе и мертвой Тисе у Лакителек и их сезонных изменений.

Помимо экологического воздействия исследования распространяются также на антропогенные факторы, влияющие на популяцию рыб.

Прослеживаются годовые изменения видов рыбной фауны в мертвом рукаве. Составлен перечень фауны и отмечены виды, появляющиеся и изчезающие из мертвого рукава. Из года в год проводились сравнительные измерения молоди, выклевывающейся в Тисе и мертвом рукаве бассейна Алпари.

Проведено сравнительное исследование питания отдельных видов рыб в Тисе и мертвом рукаве у Лакителек.

Обсуждено влияние загрязнения Тисы и мертвого рукава на рыбную фауну.

Promene riblje faune u periodično zatvorenom otseku Tise

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Abstrakt

Izučenik je izučavao sezonske promene i usporedio je stanje riblje faune između žive Tise i mrtvaje Tise kod Lakitelek od 1987. god.

Ne samo ekologički nego i antropološki utjecaji su bili izučeni.

Preko cele godine je pratio promjene vrste ribe u mrtvoj Tisi. Izradom faunskog spiska označio je pojavljene odnosno nestale vrste.

Usporedio je godišnje riblje potomke između Tise i mrtvaje kod Alpara.

Izučio je konzumiranje hrane naglašene rodove nalazene i u Tisi i u mrtvaji kod Lakitelek. Skrenuo je pažnju za zagađenje reke jer to ima veliki utjecaj za riblju faunu.

GROWTH OF CARP (CYPRINUS CARPIO L.) IN THE KISKÖRE STORAGE LAKE

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Abstract

The present study deals with growth of wild carp in the Kisköre storage lake set up in 1978 at the Tisza river, and compares the results with the data obtained in Orava storage lake (Czechoslovakia), Danube (Yugoslavia) and Körös Backwater reservoir.

The most significant differences were found in comparison with carps from the Körös backwater reservoir. Initially the body mass of carps from the Tisza storage lake is smaller but the growth rate is higher, similar tendency is observed in the longitudinal growth, too. Carps from the storage lake already at the age of five years reach the length of 7 years-old specimens from the Körös backwater reservoir, and except for the first year, their condition is also better. Most probably the rich nurtient supply of the storage lake is of decisive importance for the faster growth and better condition. Positive and negative deviations were observed as compared to the Czechoslovak and Yugoslavian data as well but those were less significant. Growth of carps in the Kisköre storage lake — though essentially more favorable than that in the Körös backwater reservoir — cannot be qualified as outstanding, just as satisfactory for the circumstances.

Introduction

Since 1978 a storage lake has been set up at the Tisza river, which lacking an official name was named initially Tisza—II, afterwards the Kisköre storage lake, and lately the Tisza lake.

Since the area of the lake measuring approximately 100 km² is being covered by water only from spring till autumn, the fish inhabiting it withdraw in the winter season to the deep water of the river and abandoned river beds.

Since 1970 ichtyological studies are being carried on in this region. The aim of these investigations is on the one hand to study the composition as well as the changes occurring in the fish fauna (HARKA 1974, 1985), and on the other hand, to follow the growth of economically important species, such as pike-perch, pike and sheatfish (HARKA 1975a, 1977, 1983, 1984).

The aim of the present study was to investigate the growth of wild carp found in the storage lake, since the data available till now concerned only mirror carp introduced from fish breeding pond (HARKA, 1975a). From the economical point of view the importance of carp is comparable to that of the above mentioned species. The average catch of carp from the storage lake in the last seven years exceeded 47 tons. The majority of the specimens belonged to the wild type but due to the regular introduction of cultured forms, the carp stock of the storage lake differs from the original wild form.

Materials and Methods

The data of 220 carps caught between 1983 and 1987 in the north-eastern pool of the storage lake, in the vicinity of the settlements Tiszafüred and Poroszló, were used in the growth studies. The standard lenght of the specimens (measured between the nose and the beginning of the tail-fin) ranged between 300 and 670 mm, whether the body mass varied between 730 and 7410 g.

The relationship between the body length (L) and body mass (W) was calculated according to the formula suggested by Tesch (1971) ($W=aL^b$), respectively in its logarithmic form. The curves were fitted to the measured data by the least squares method (SVÁB 1973).

The age of the specimens was determined scalimetrically. The full oral radius of the scales (S) and the distance of the successive winter annuluses from the focus of the scale (S_n) were measured using a Zeiss microfilm reader and a mm scale under 21,5-fold magnification.

The expected length of a specimen (L_n) corresponding to the formation of a given annulus was calculated according to FRASER (1916) and LEE (1920) from the relationship

$$L_n = c + \frac{S_n}{S}(L-c)$$

where L is the measured body length of the caught fish, and c is the correction member originating from the relationship between body length and scale radius.

Growth was described by the BERTALANFFY mathematical growth model developed by BENEVERTON and HOLT (1957), and suggested further by DICKIE (1971). According to the Bertalanffy equation at the age of t years the body length of fish (L) can be expressed as follows:

$$L_t = L_\infty [1 - e^{-k(t-t_0)}].$$

The values of the parameters entering the equation, i.e. the assymptotic body length (L_∞), the growth rate constant (k) and the hypothetical age (t_0) corresponding to L=0, were estimated as suggested by Guland (1963).

The condition factor (CF) was calculated according to HILE (1936) as a ratio of the body mass (measured in g) and the cube of the body length (in mm).

Results and Discussion

Relationship between body mass and body length.

The following relationship was found between the body mass (W) and the standard body length (L_c) in carps on the basis of 220 data pairs:

$$\lg W = -4{,}1725 + 2{,}8291 \lg L_c.$$

The body mass and the body length were measured in g and mm, respectively. The correlation coefficient (r) is 0,96. In case the full length (L_t) is used in the calculations, the relationship is as follows:

$$\lg W = -4{,}6479 + 2{,}9274 \lg L_t \qquad (r=0{,}96).$$

Till now in Hungary the growth of wild carp has been investigated by similar methods in the Körös backwater reservoir (TALAAT and OLÁH, 1986). Comparing the results obtained in the two basins, it can be concluded that although carps from the storage lake initially have a smaller body mass, the rate of mass growth is higher. They catch up already at the end of the first year (the average length at that age being 153 mm) and from that time on their advantage is steadily increasing.

Relationship between body length and scale radius

Regression analysis of the standard body length (L_c) and full scale radius (S) led to two relationships presented in Fig. 1. For specimens with body length ranging from 300 to 420 mm

$$L_c = 20{,}13 + 1{,}425\ S \qquad (r = 0{,}98)$$

whether for specimens longer than that

$$L_c = -41{,}2 + 1{,}784\ S \qquad (r = 0{,}96)$$

relationships were obtained.

In the estimation of the actual body length (L_n) the calculations in every case were started using the correction member from the first equation (c=20,13), and only after the calculated actual length reached 420 mm the correction member derived from the second equation was applied (c= −41,2). This length was reached at the age between 4 and 5 years. However no break was observed in the growth curve in this age group either, since in approximately 50% of the cases the first and in the rest-the second correction member was applicable which resulted in a compensatory effect.

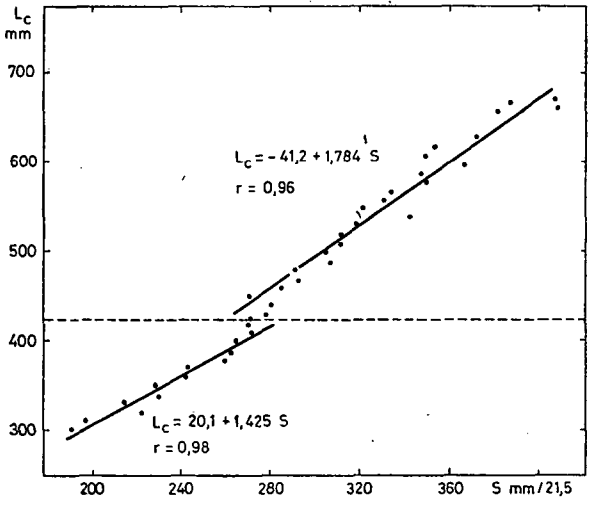

Fig. 1. Relationship between standard body length (L_c) and the full oral scale radius (S)

Time dependence of the longitudinal growth

The age of 216 specimens studied, as determined on the basis of scale examination, ranged from 2 to 9 years. The number of specimens belonging to different age groups (n) is given in Table 1. Since only one 9 years-old fish was found, it was included in the group of 8 years-old specimens, the growth in the 9th year was not evaluated.

Table 1. *Standard body length of carps belonging to different age groups in successive year of their life*
(L_1, L_2, etc. in mm)

Age		2	3	4	5	6	7	8—9	2—9	W
n		12	73	43	27	33	17	11	216	(g)
	a	90	70	86	90	97	92	108	70	
L_1	b	161	173	143	136	161	134	138	173	
	c	131	113	115	116	123	116	120	119	50
	a	221	163	154	170	151	167	178	151	
L_2	b	312	301	284	287	270	249	246	287	
	c	266	224	206	209	218	207	209	220	285
	a		240	191	229	235	248	243	191	
L_3	b		415	397	375	358	351	348	415	
	c		313	290	309	317	297	294	303	704
	a			318	338	307	320	314	307	
L_4	b			474	463	454	429	428	474	
	c			393	393	405	382	376	390	1438
	a				411	390	399	398	390	
L_5	b				541	543	490	507	543	
	c				461	475	446	438	455	2225
	a					451	453	473	451	
L_6	b					618	587	543	618	
	c					536	520	504	520	3246
	a						498	533	498	
L_7	b						625	586	625	
	c						571	558	565	4105
	a							576	576	
L_8	b							617	617	
	c							594	594	4730

a: minimum, b: maximum, c: average

The calculated standard body lengths reached by the specimens belonging to different age groups during successive years of their life are listed in Table 1. The body mass (W) given in the Table is calculated from the relationship discussed above using the average body length.

A saturation function was fitted to the body length data calculated on the basis of the year marks on the scales. It is described by a BERTALANFFY equation with the following calculated parameters: assymptotic body length (L_∞) 828,1 mm, the growth rate constant (k) 0,1625, the hypothetic age corresponding to zero length (t_0): +0,076 years. From the above follows that at the age of t years the expected standard body length (L_t) of wild carps inhabiting the north-eastern pool of the storage lake can be calculated from the following relationship:

$$L_t = 828{,}1\,[1 - e^{-0{,}1625\,(t-0{,}076)}].$$

The body lengths calculated on the basis of scale year marks and the BERTALANFFY equation are listed in Table 2. The comparison of the results shows that the function

Table 2. *Standard body length (in mm) reached in successive years by carps from the Kisköre storage lake as determined on the basis of scales and calculations according to the* BERTALANFFY *equation*

Age (year)	Calculated body length on the basis of scales	Bertalanffy's equation
1	119	115
2	220	222
3	303	313
4	390	390
5	455	456
6	520	512
7	565	559
8	594	600

is suitable for growth modelling, since the differences do not exceed 10 mm, which value is comparable with the permissible error limit in measuring of body length. (The positive value of t_0 indicates that the model is not applicable for specimens below one year.)

The growth curve is shown in Fig. 2, together with the calculated average and extreme values. The narrow range of the extreme values at the age of 7—8 years is due to the small number of specimens in this group.

Since in the studies of growth of carp both full (L_t) and standard (L_c) body lengths are being used by different authors, for the sake of comparison a relationship between the two values for carps from the storage lake is presented below:

$$L_t = 17{,}1 + 1{,}444\, L_c \qquad (r = 0{,}99)$$

Fig. 3 shows the results of the present study together with data on growth of carp in the age groups from 1 to 8 years in Czechoslovak (Drava storage lake), Yugoslavian (Danube) and Hungarian (Körös backwater reservoir) basins.

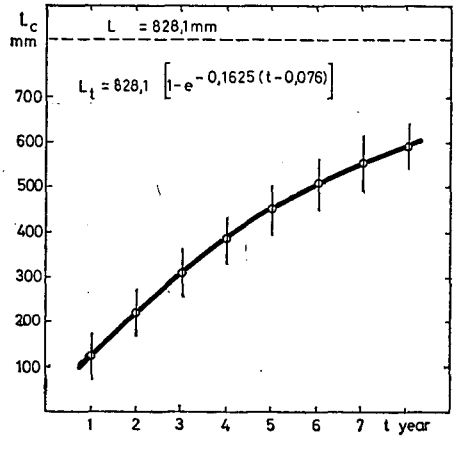

Fig. 2. Growth of carp in the Kisköre storage lake calculated according to the Bertalanffy-equation. Points represent the mean values based on scale marks measurenments, vertical bars show the extreme values

Table 3. *Conditional factors (CF, x10⁵) of carps from the Körös backwater reservoir and the Kisköre storage lake ranging in age from 1 to 8 years*

Age (year)	1	2	3	4	5	6	7	8
Körös backwater	1,55	1,43	1,35	1,31	1,28	1,26	1,24	1,23
Kisköre storage lake	1,39	1,46	1,45	1,44	1,42	1,41	1,40	1,39

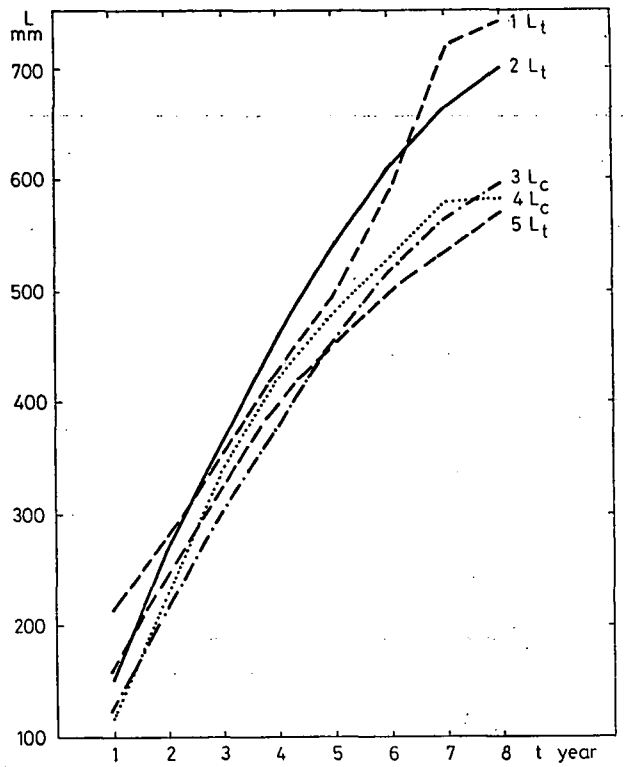

Fig. 3. Growth of full (L_t) and standard body length (L_c) of carps in several neighbouring basins. 1. Yugoslavian Danube-section (Ristić 1971), 2—3. Kisköre storage lake (present study). 4. Orava storage lake (Balon 1967). 5. Körös backwater reservoir (Talaat and Oláh 1986)

The most significant differences were observed in comparison to carps from the Körös backwater reservoir in elder age groups. E.g. carps from the storage lake already at the age of 5 years reached the length of the 7 years-old fish from the backwater reservoir. Further advantage was their better condition, their body mass being bigger by 250 g. On the basis of the conditional factors (CF) listed in Table 3, it can be seen that carps from the storage lake under one year have certain drawbacks, but above that age they catch up and gain advantages over those from the backwaters. Most probably the main role in their faster growth and better condition is played by the richer nutrient supply in the storage lake. The somewhat unexpected

drawbacks experienced during the first year could be possibly explained by the protracted reproduction of carps in the storage lake. Although the sprawning starts already in the beginning of April, it still can be observed even in July, thus leading, to the uderdevelopment of the late progeny.

Positive and negative deviations were observed as well in comparison to carps from the Danube-section and Drava storage lake but those were less significant. Summing up it can be concluded that growth of carps in the Kisköre storage lake — though essentially more favorable than in the Körös backwater reservoir — cannot be qualified as outstanding, just satisfactory under given climatic and other circumstances.

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A ponty (Cyprinus carpio L.) növekedése a Kiskörei-tározótóban

HARKA Á.

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Kivonat

A tanulmány ismerteti a Tisza folyón 1978-ban létesített Kiskörei-tározótó vadpontyainak növekedését, majd az eredményeket összeveti a csehszlovákiai Orava-tározótóra, a jugoszláv Dunaszakaszra és a Körös holtágaira vonatkozó adatokkal.

Nagyobb eltérések a Körös-holtágak pontyaival szemben mutatkoztak. A tiszai tározótó

pontyai kisebb testtömeggel startolnak, de tömegnövekedésük üteme gyorsabb, s hasonló a helyzet a hossznövekedésben is. A tározótó pontyai már 5 éves korban elérik azt a hosszt, amelyet a Körös-holtágak pontyai csak 7 éves korban, s az első évet leszámítva kondíciójuk is jobb. A gyorsabb növekedésben és a jobb kondícióban minden bizonnyal a tározótó gazdag táplálékkészlete játssza a főszerepet.

A csehszlovákiai és jugoszláviai adatoktól pozitív és negatív irányú eltérések egyaránt adódnak, de ezek kevésbé jelentősek. A Kiskörei-tározótóban élő pontyok növekedése tehát — bár lényegesen kedvezőbb, mint a Körös-holtágakban — nem kiemelkedő, csupán a körülményeknek megfelelő.

Рост карпа (Cyprinus carpio L.) в водохранилище кишкёре

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Резюме

В статье описан рост дикого типа карпа в водохранилище Кишкёре, построенном на Тисе в 1978 г.; результаты исследований сравниваются с данными, полученными в чехословацком водохранилище Орава, югославском отрезке Дуная и мертвых руслах Кёрёша.

Самые значительные различия наблюдали в сравнении с карпами мертвых русел реки Кёрёш. Начальная масса карпов тисайского водохранилища меньше, но скорость приращения массы больше, аналогичная тенденция наблюдается в отношении продольного роста. В водохранилище карпы уже в возрасте 5 лет достигают длины семилетных особей из мертвых русел реки Кёрёш и, за исключением первого года жизни, их кондиция также лучше. Вероятно, основной причиной быстрого роста и лучшей кондиции является богатый запас питательных веществ в водохранилище.

В сравнении с данными, полученными в Чехословакии и Югославии, наблюдались как положительные, так и отрицательные отклонения, которые, однако, были менее значительными. Рост карпов в водохранилище Кишкёре, будучи более благоприятным в сравнении с мертвыми руслами реки Кёрёш, все же не является выдающимся, а лишь соответствующим условиям окружающей среды.

Prirast šarana (Cyprinus carpio L.) u rezervoaru za vodu Kisköre

Harka A.
Gimnazija „Kossuth Lajos"; Tiszafüred

Abstrakt

Rad prikaziva prirast šarana u rezervoaru za vodu na Tisi napravljen 1987. god. kod Kisköre.

Rezultati uspoređeni sa podacima čehoslovačkog rezervoara za vodu „Orava", sa podacima jugoslovenskog otseka Dunava i sa rezultatima mrtvaje Körös. Vidne su veće diferencije sa mrtvajom Körös.

Šarani iz Kisköre u početku su dosta manjeg rasta ali poslije prirast tjelesne težine i dužine je brža.

Šarani iz rezervoara za vodu Kisköre tu tjelesnu dužinu dostižu u petoj godini života što šarani iz mrtvaje Körös u sedmoj godini; isključenjem prvu godinu života dostižu i bolju kondiciju.

Ova činjenica potvrđuje da rezervoar za vodu Kisköre je bogatiji hranom od mrtvaje Körös.

Rezultati u poređenju sa čehoslovačkim i jugoslovenskim podacima su pokazali diferenciju i u pozitivnom i u negativnom pravcu ali te diferencije su bile neznatne.

Prirast šarana-uprkos da su uslovi mnogo bolji- u rezervoaru za vodu Kisköre, nije istaknuta, odgovara se samo okolnostima.

FISH GROWTH RATE IN THE TISA DEAD-ARM (ČURUG—BISERNO OSTRVO) DEPENDING ON TYPE OF NUTRITION

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Abstract

The growth of 8 fish species, belonging to different types of nutrition (planktophagous: *Scardinius erythrophthalmus* and *Rutilus rutilus.*, planktobenthophagous (benthoplanktophagous): *Abramis brama, Carassius carassius* and *Carassius auratus gibelio* and fish of pray: *Esox lucius, Perca fluviatilis* and *Stizostedion lucioperca)* was studied, based on the material caught during 1987. It was shown that in this eutrophic lake tested fish species had different rate and constant of growth, which is undoubtedly closely related to the type of nutrition, although the importance of other factorsaffecting the growth of some fish species within their ecologic valence should not be ignored.

Introduction

During the past ten years (1979—1988) within complex ichthyological studies in the Tisa river basin, we have analysed body mass and longitudinal growth of the several fish species of variable economic value (MALETIN et BUDAKOV 1983, 1984, 1986). Detailed studies have been especially carried out in the Mrtva Tisa, Biserno Ostrvo/lake, considering the trophic level (eutrophic) of this hydroecosystem which shows a tendency of futher acceleration. An interesting question has arisen regarding the growth intensity of some fish species with different types of nutrition, during past five to ten years, due to a constant increase in the trophic level, inspite of the fact that water quality remained within acceptable levels. This applies to oxygen regime, pH value, hydrological conditions in this water basin and lack of considerable pollutants (this being one of a rare water basins which receives neither industrial nor large volumes of sewerage waters (MALETIN et al. 1987). Similar studies have been already performed in some other lakes ecosystem HARTMAN (1978) for example, analysing the growth of fish species from some regions of the lake Constance found a correlation between the growth and the lake trophic level changes (from oligo-over mezo — to eutrophic level) during the past fifty years.

Materials and Methods

During the last decade studied were fish collected with fishing net, trap (40—70 mm mash openning), and.by electric fishing (3 KW and up to 280 V).

The growth of body mass, standard lenght (measured and calculated), and growth rate, constant and characteristic of 8 fish species were analysed. These fish belonged to different nutrition types: planktophagous: *Scardinius erythrophthalmus* and *Rutilus rutilus.* planktobenthophagous (benthoplanktophagous) *Abramis brama, Carassius carassius, C. auratus gibelio* and fish of pray *Perca fluviatilis, Exos lucius and Stizostedion lucioperca.*

The age of tested specimen varied from 0+ to 4+, and was determined along with the reconstruction of longitudinal growth, on the basis of generation zones on the scales.

Results and discussion

Specimen aging from 1+to 4+were used to analyse *S. erythrophthalmus* body growth. Body mass growth ranged from 5 to 22 g with most intensive growth recorded between the third and the fourth year (Fig. 1). *P. fluviatilis* mass growth ranged from 4 to 31 g (age 0+to 2+) with high rate clearly expressed after the first year. *R. rutilus* showed very dynamic body mass growth, reaching 300 g in its fifth year. *C. auratus gibelio,* however showed surprisingly low body mass growth intensity (after the age of 2+). The same has been recently found in some other waters in this part of the Pannonian plane. This phenomenon may be explained by general stagation in the population dynamics, which occurs after fish introduction in most alochtonous species, following the initial explosion and expansion in the expanded part of an are. However, the possibility of a complex infraspecies chategories of different dimensions, first of all body mass and standard length may not be excluded. The growth of *C. carassius* was somewhat slower compared to the growth of *C. auratus gibelio* (more intensive period was noticed between the third and the fourth year of age). Satisfactory growth was shown by *A. brama.*

It reached 300 g at the age of 3+. The body mass growth of inchthyophaga is the most impressive. *E. lucius* and *S. lucioperca* in particular proved very good results in this ecosystem (the first fish of pray weighted 1300 g and the second weighted 1800 g at the age of 3+).

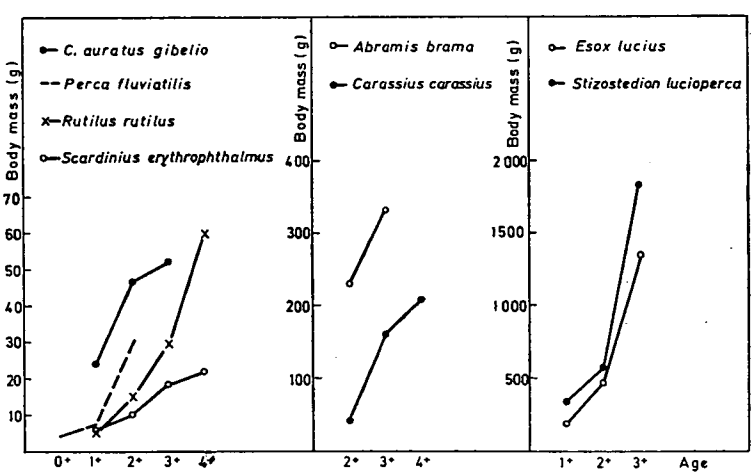

Fig. 1 Body mass growth of fish in dependence on age

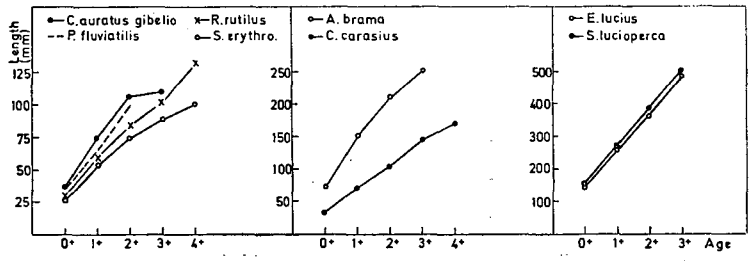

Fig. 2a Length growth of fish in dependence on age (measured values)

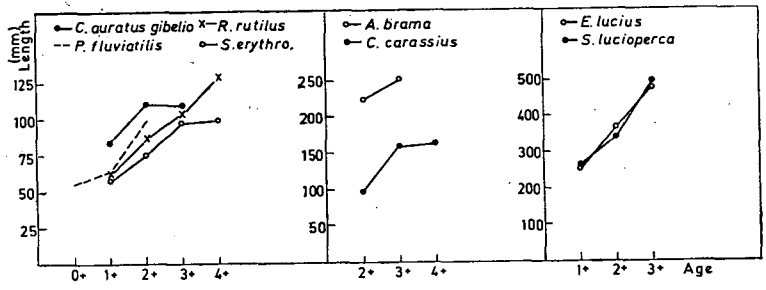

Fig. 2b Length growth of fish in dependence on age (calculated values)

The analysis of longitudinal growth (measured and calculated values) showed similar tendency and relation between fish species within tested groups according to types of nutrition (Fig. 2 and 2a). Insignificant difference was found in standard lenght values in particular years of fish existence between *E. lucius* and *S. lucioperca*. The most planktophagous fish also proved good longitudinal growth, except *C. auratus gibelio*, which showed considerable stagnation after the age of 2+. *A. brama*, *R. rutilus*, *P. fluviatilis* and *S. erythrophthalmus* had the best longitudinal growth.

The analysis of rate, constant and growth property added to more consise survey of fish longitudinal growth (Fig. 3). The growth rate in most studied species had a common decreasing tendency in relation to an age increase. Moreover, two specific periods may be distignuished in species in which longitudinal growth was analysed over a period of several years (3—4 years), with the exception of *R. rutilus* (cyprinids) and *S. lucioperca* (fish of pray) which manifested an increased growth rate in the fourth i.e. in the third year of age.

The growth constant manifested similar results. With regard to this parameter, *R. rutilus*, *A. brama* and especially fish of pray (first of all *S. lucius*) had a tendency of a constant increase. These values, however, reflected upon the growth characteristic with similar increasing and decreasing tendency for the aforementioned fish species. Further analysis was directed towards the comparison of growth values and their tendencies between samples caught in 1987 and samples caught five or ten years before that. (Fig. 4). For this purpose the aforementioned parameters of longitudinal growth in two benthoplanktophagous fish *(A. brama* and *C. auratus gibelio)* and two ichthyophagous fish *(E. lucius* and *S. lucioperca)*.

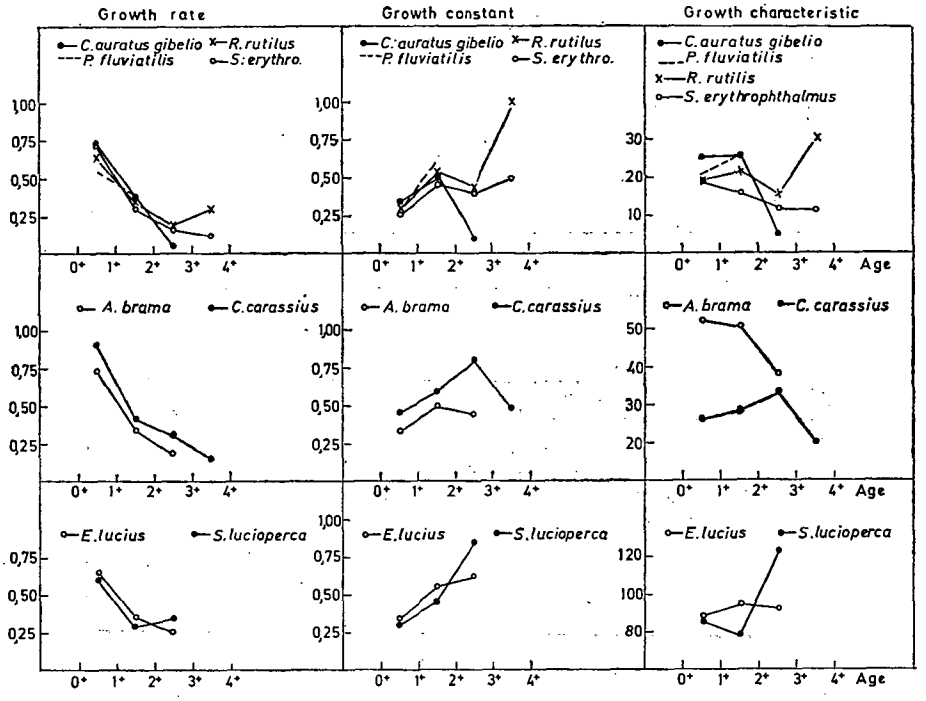

Fig. 3 Growth rate, constant and characteristic of fish

C. auratus gibelio samples caught in 1987 leged considerably behind samples caught in 1983 and 1984., with respect to longitudinal growth mean values (difference between two last samples in certain age categories was insignificant).

Eventhough sample from 1987 showed higher growth rate, compared to samples collected before that time, differences were insignificant. On the other hand, growth constant and characteristic leged considerably behind in most recently collected samples, thus again explaining the position of this subspecies population in this water basin. The growth of *A. brama* sample, caught in 1987 was more satisfactory compared to samples collected in the previous years (1979—1982). This was related to values at age 2+ and 3+ and was based on the rate and growth characteristic. Growth constant was also manifested with higher values for the same sample in different age groups and uniformity without great fluctuations. Better longitudinal growth was also recorded for *E. lucius* and *S. lucioperca* ichthyophagous species, analysed in 1987., when compared to the same species in the Mrtva Tisa, collected eight to ten years before that. In both species, after the first two years of life with approximately the same standard length values, sudden rise in the growth intensity was manifested, with further increase in the following two year period with considerable difference.

Rate values and growth characteristics indicated constant increasing tendency, compared to previously fished samples, in which these parameters varied either as flactuations *(E. lucius)*, or decreasing tendency *(S. lucioperca)*.

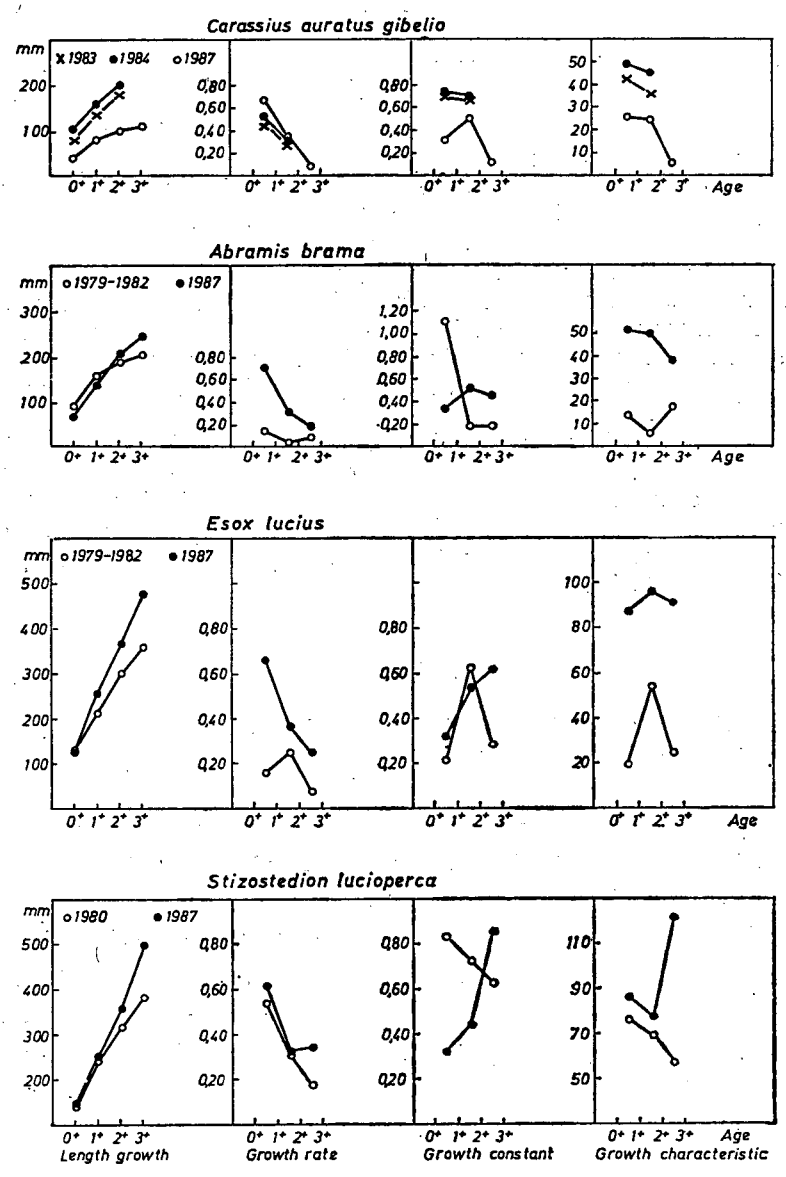

Fig. 4 Some length growth parameters of fish during eutrofic status (Period 1979—1987)

Body mass and longitudinal growth of these fish of pray, caught in the Mrtva Tisa during 1987 had values similar to those stated by HARKA (1983) for *E. lucius*, or even surpassed them (for *S. lucioperca*, HARKA 1977) of Hungarian Tisa section. It would be interested to compare the growth results of *S. lucioperca* from the Mrtva Tisa with recent data of this fish from the middle Tisa basin, in order to evaluate a trophic level in this part of the river flow.

Conclusion

Based on the growth analysis of 8 fish species in the Mrtva Tisa — Biserno Ostrvo Lake, belonging to different types of nutrition (planktophagous, planktobenthophagous, and ichthyophagous) it may be concluded that the best growth was manifested by *R. rutilus, A. brama, E. lucius* and *S. lucioperca.*

P. fluviatilis and *S. erythrophthalmus* species showed good body mass and longitudinal growth, while *C. carassius* and *C. auratus gibelio* in particular, as typical representatives of benthophagous fish manifested modest growth results in this ecosystem. The growth of fish of pray, living in two different living space is particularly impressive. This confirmed that in addition to sufficient quantities of food, these ichthyophagous fish were adopted to other environment conditions. Out of four species used for comparing the growth among samples caught in 1987 and five to ten years before that, only *C. auratus gibelio* showed slower growth during the surveyed period.

Samples of other three species *(A. brama, E. lucius,* and *S. lucioperca)* caught in 1987 manifested better growth then earlier collected samples.

Such results may point to the inferior environment quality in the benthos zone, especially in the section with muddy bottom, compared to other zones, first of all with shallow sections and macrophyte vegetation (habitat of *E. lucius)*, or solid bottom (habitat of *S. lucioperca).*

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A Holt-Tisza (Čurug—Biserno Ostrvo) halainak növekedése a táplálkozási típusok függvényében

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Kivonat

A szerzők különböző táplálkozási típusokhoz tartozó 8 halfaj növekedési ütemét vizsgálták 1987-ben a Holt-Tiszából begyűjtött példányokon, éspedig:
— Planktofág: *Scardinius erythrophthalmus, Rutilus rutilus*
— Planktobentofág: *Abramis brama, Carassius carassius, Carassius auratus gibelio*
— Ragadozó: *Esox lucius, Perca fluviatilis, Stizostedion lucioperca*
Megállapítást nyert, hogy a tanulmányozott halfajok növekedési üteme közötti eltérés egyrészt a táplálkozási típusok függvénye az ökológiai valencia keretein belül a többi számos tényező mellett, a Holt-Tisza eutróf tavi rendszerében.

Рост рыб в мертвой Тисе (Чуруг — Бисерно Острво) в зависимости от типа питания

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Резюме

Авторами исследована динамика роста 8 видов рыб, отличающихся разными типами питания, на особях, пойманных в мертвой Тисе в 1987 г.:
— Планктофаги: *Scardinius erythrophthalmus, Rutilus rutilus*
— Планктобентофаги: *Abramis brama, Carassius carassius, Carassius auratus gibelio*
— Хищные: *Esox lucius, Perca fluviatilis, Stizostedion lucioperca*
Было установлено, что различия в динамике роста исследованных видов рыб являются помимо многочисленных других экологических факторов функцией питания в эутрофной системе озер мертвой Тисы.

Tempo rasta riba u mrtvoj Tisi (Čurug—Biserno Ostrvo) u zavisnosti od tipa ishrane

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Abstrakt

Ispitivan je rast 8 vrsta riba koje pripadaju različitim tipovima ishrane (planktofagni: *Scardinius erythrophthalmus* i *Rutilus rutilus* planktobentofagni (bentoplanktofagni): *Abramis brama, Carassius carassius* i *Carassius auratus gibelio* i grabljivice: *Esox lucius, Perca fliviatilis* i *Stizostedion lucioperca)* na osnovu ulovljenog materijala u toku 1987. godine, pokazano je da u ovom eutrofnom rečnom jezeru ispitivane vrste riba ostvaraju različitu brzinu i konstantu rasta što je svakako u vezi sa načinom ishrane, mada se ne može isključiti značaj delovanja ostalih faktora na rast pojedinih vrsta u okviru njihove ekološke valence.

THE GROWTH AND FECUNDITY OF LEPOMIS GIBBOSUS (PISCES: CENTRARCHIDAE) IN THE TISA DEAD-ARM (ČURUG—BISERNO OSTRVO)

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(Received December 15, 1988)

Abstract

L. gibosus growth and fecundity were analysed in the former Tisa river meander, which was separated from the river bed in the middle of the last century.

Introduced into Europe over 100 years ago, this allochtonous species was quickly naturalized in this part of the expanded area. Material for this study was collected during 1985. A total of 273 specimen againg from 3+ to 7+, with average standard lenght from 102 to 146 mm and body mass from 48 to 111 g was studied.

The longitudinal growth of L. gibbosus in the Mrtva Tisa had values similar to those of specimen in their native locality. The mean value of the absolute fecundity ranged, depending on age, from 4.474 to 11.668 eggs, and relative fecundity from 111 to 127. There was a considerable correlation between increasing absolute fecundity and an increase in age, standard lenght and body mass, where as only a slight correlation was found between a relative fecundity and basic biological parameters.

Introduction

L. gibbosus originated from the North America and into the European waters it was introduced as early as the end of the last century. This fish of pray, from the *Centrarchidae* family, quickly spread across the Continent, at first as an ornamental fish, because of its atractive appearance. Coming to open water systems quickly was it adjusted, becoming a significant member of an ichthyofauna, particulary in the stagnant and slow flowing waters. Without any economic valute, the presence of this allochtonous species in waters is clearly harmful, because of its direct competition for a living space and nutrition, with allochtonous species *(Perca fluviatilis, Gymnocephalus cernua)*. Direct damage comes from its feeding on roe and young fish of other species. Large number of this fish in total catch, in the lower of the Tisa river basin, was suggested by RISTIĆ (1940). Recent ecological studies of *L. gibbosus* focus on problems of diet in one, for this species typical habitat space, such as canals and stagnant tributaries (PUJIN et al. 1985, 1986).

In more detailed ecological studies, our aim was to analyse total body growth and potential fecundity, because these basic biological parameters (along with fish abundance) are the best indicators of the essential population properties. These studies are also important, bearing in mind that allochtonous species is surveied. The studied population of *L. gibbosus* comes from a characteristic habitat space of one water ecosystem, such as the Mrtva Tisa, former meander of the Tisa river, separated from the river bed as far back as the middle of the last century.

Materials and Methods

Material for these studies consisted of 273 specimen of *L. gibbosus* caught during 1985. Body mass and longitudinal growth during the life span were analysed, based on the mean annual values. The rate of longitudinal growth was calculated, using the following formula:

$$C = \frac{10\ g\ l_2 - 10\ g\ l_1}{0.4343 \cdot (t_2 - t_1)}$$

where l_1 and l_2 represent mean values of caluclated standard length, and t_1 and t_2 represent the age of specimen in two concecutive years, (age was determined on the basis of the generation sclerite zones on the scales). Growth constant was calculated using the formula:

$$K = C\frac{t_1 + t_2}{2}$$

Growth characteristic was also determined according to the formula C. 1. Given parameters were shown in correlation with age.

The absolute and relative fecundity was also studied in relation to age, standard length and body mass.

Correlation coefficients were calculated both for the absolute and relative fecundity in relation to the aforementioned parameters.

Results and Discussion

The age of studied specimen ranged from 3+ to 7+. Body mass mean values showed an increase compared to age, and ranged from 41 g at the age of 3+ to 111 g at the age of 7+. Individual body mass values varied from 30 g to 131 g. Standard deviation amounted from 5,65 for the youngest specimen (3+) to 23,19 for the specimen at the age of 6+, with an increasing tendency (Fig. 1).

The highest value of the absolute body mass growth, expressed in grams, and relative growth calculated in percentages, appeared to be between the age of 4+ and 5+, i.e. (26.49 g and 54.06% respectively. Further absolute and relative growth demonstrated gradual decrease (Fig. 2).

The measured and calculated values of the standard body length revealed an increase with regard to age and these two curves were almost identical.

The measured individual values of the standard body mass ranged from 88 to

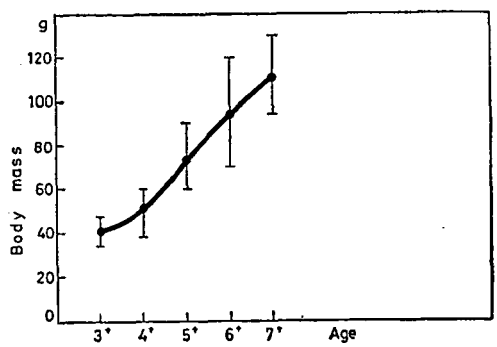

Fig. 1 Body mass of *L. gibbosus* in dependence on age

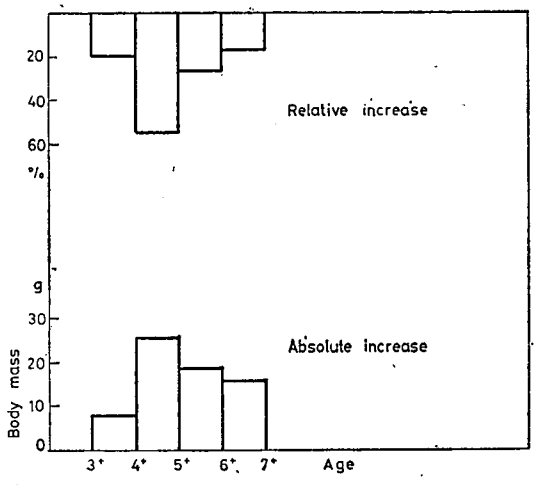

Fig. 2 Body mass absolute and relative increase of *L. gibbosus* in dependence on age

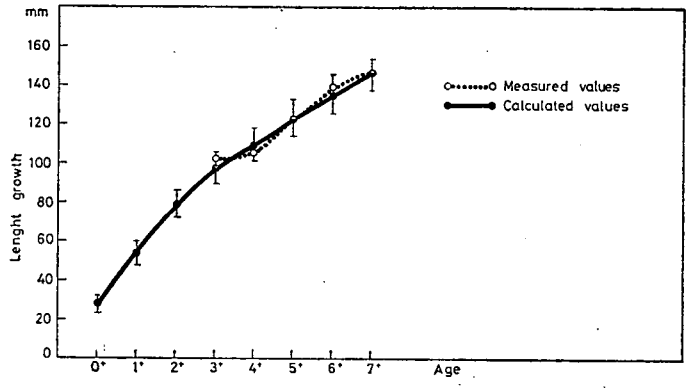

Fig. 3 Length growth of *L. gibbosus* in dependence on age

152 mm in the whole sample, while the calculated mean values ranged from 102.19 to 145.83 mm (age 3+ to 7+).

At the same time, calculated values ranged from 28.62 mm at the age of 0+ to 145.83 mm at the age of 7+. An increasing trend was also displaied by standard deviation. The lowest value of 3.896 was recorded at the age of 0+, where as the highest value of 10.121 was recorded at age of 6+ (Fig. 3).

Body mass and longitudinal growth values did not leg behind the values achieved by this species in its native area. (KEAST 1978). Poorer longitudinal growth was caused rather by somewhat shorter vegetation period in this part of the expanded area, compared to the native area, then by difficulties in the process of acclimatization. On the contrary, quickly after introduction, this species adapted and natural spawn was recorded.

A decrease in the absolute and relative growth of the calculated standard lenght values was recorded with regard to age (Fig. 4).

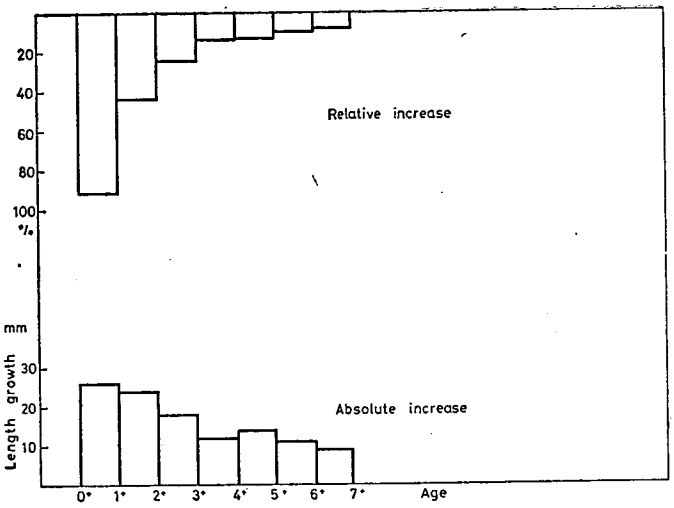

Fig. 4 Length growth absolute and relative increase of *L. gibbosus* in dependence one age

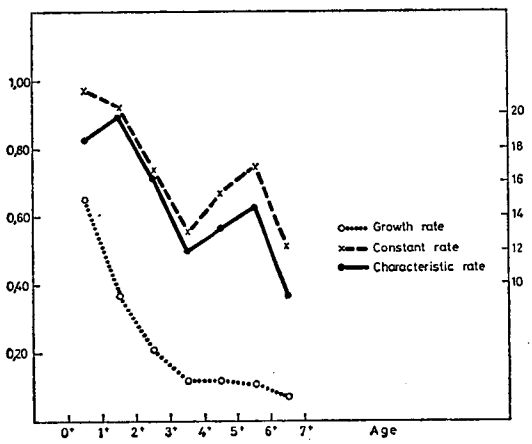

Fig. 5 Growth rate, constant and characteristic of *L. gibbosus* in dependence on age

This decrease was rather uniform, except between the age of 4+ and 5+, when slight growth increase was noticed, compared to the previous period between the age of 3+ and 4+.

In relation to age, growth rate revealed common decline, and it was more expressed up to the age of 4+, after which it become gradual. Decrease of the growth constant and rate (Fig. 5) was recorded up to the age of 4+, after which the parameters varied with considerable increase up to the age of 6+, followed by another decline. Growth characteristic varied in the similar fashion as the growth constant, with two peaks in the total decline trend during the fish life span.

Potential fecundity was analysed in 52 female specimen, aging from 3+ to 7+.

The absolute fecundity mean values ranged from 4.474 to 11.668 eggs, showing a trend of increase compared to age, standard length and body mass (Fig. 6). In the entire sample, individual absolute fecundity varied from 2.565 (specimen age 4+, standard length 81—100 mm, body mass 41—60 g) to 21.168 eggs (specimen age 6+, standard lenght 121—140 mm, body mas 81—100 g).

At the same time, relative fecundity mean values ranged from 111 to 127 eggs, and varied in relation to the basic parameters. Relative fecundity individual values ranged from 48.90 (female specimen age 6+, standard length 101—120 mm, and body mass 61—80 g), to 252.00 (same age, body mass and length similar to the ones in female specimen with the relative fecundity).

This showed low correlation between relative fecundity and aforementioned parameters.

Standard deviation of the absolute and relative fecundity mean values among particular age, longitudinal and mass groups was also different. Standard deviation of the absolute fecundity was the lowest in specimen aging from 3+, with standard length of 81—100 mm and body mas of 21—40 g. It was increased with age and reached the highest value at age of 6+, with standard length of 121—140 mm and body mass of 101—120 g.

Irregular variation of this parameter was noticed in relative fecundity, with the lowest value recorded in female specimen at the age of 7+, with standard lenght of 141—160 mm and body mass of 121—140 g. The highest values, however, were found in specimen at the age of 6+ and body lenght of 121—140 mm and body mass of 81—100 g.

The correlation level between the absolute and relative fecundity and particular parameters (age, length and body mass) in further studies was expressed by correlation coefficient. There was positive correlation between the absolute fecundity and basic parameters, with coefficient, ranging from $r=0.5583$ (in relation to age) to $g=0.6616$ (in relation to body mass).

In spite of being positive, the correlation between the relative fecundity and abovementioned parameters was very low. In fact, the correlation was insignificant. The lowest correlation coefficient in relation to the standard lenght was shown by relative fecundity, ($r=0.0097$), while the highest one was observed in relation to the body mass ($r=0.0354$).

Further fecundity analysis was aimed at studing the correlation links within certain age, longitudinal and body mass groups.

Examining the correlation in specimen, in certain longitudinal groups, led us to a conclusion that most correlation coefficients were negative, with the smallest value recorded between the absolute fecundity and standard length in the 101—120 mm length group ($r=-0.0960$) and the highest value in the 81—100 mm length group ($r=0.6783$).

The correlation between relative fecundity and standard length of specimen in certain group intervals was also negative, ranging from insignificant ($r=-0.1972$., 121—140 mm group) to significant ($r=-0.6480$ mm, 81—100 mm group).

The correlation between potential fecundity and body mass was even broader, especially when this phenomena was viewed within certain group intervals.

This correlation ranged from insignificant to high, and contrary to the correlation with standard length, the coefficients here were generally positive.

Therefore, the absolute fecundity and body mass correlation coefficient was the lowest in the group interval ranging between 81—100 g ($r=-0.0183$) and the highest in the group interval ranging between 121—140 g ($r=1.00$).

The minimum and maximum relative fecundity correlation coefficients were also recorded in the same mass group ($r = -0.0883$ and $r = 1.00$ respectively). Negative correlation coefficient values were recorded only in two groups with body mass of 21—40 g and 81—100 g.

Conclusions

— The longitudinal growth and body mass of *L. gibbosus* from the Mrtva Tisa was analysed on the basis of sample with 273 specimen aging from 3+ to 7+. Fecundity was also studied, examining 52 female specimen.

— In relation to age, body mass mean values were increased, ranging from 41 g to 111 g.

— The highest absolute and relative body mass growth, and measured standard lenght values showed and increase. Measured mean values ranged between 102.19—145.83 mm, as where calculated mean values ranged between 28.62—145.83 mm.

— The growth rate, constant and characteristic showed a decline up to the age of 4+, after which growth constant and characteristic experienced an increase, while the rate continued to decrease.

— Considerable correlation was observed in the absolute fecundity increase in relation to the increasing age, standard lenght and body mass. However, relative fecundity and basic biological parameters had an insignificant correlation.

— The highest correlation coefficients were observed between the absolute and relative fecundity on one side, and the body mass on the other.

The satisfactory body mass and longitudinal growth, along with high potential fecundity values pointed to the viability of all living conditions in certain parts of this ecosystem, typical of *L. gibbosus* living space, as well as to the successfull naturalization of this allochtonous species in this section of the expanded area.

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A Lepomis gibbosus (Pisces, Centrarchidae) növekedése és termékenysége a Holt-Tiszában (Čurug—Biserno Ostrvo)

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Kivonat

A szerzők az 1985. év folyamán a Holt-Tiszából begyűjtött 273 *L. gibbosus* egyed vizsgálatát végezték a növekedés és termékenység függvényében. A 3+—7+ életkorba tartozó példányok átlaghossza 101—146 mm, tömege 48—111 g. Az abszolút termékenység középértéke az életkortól függően 4.474—11.668, a relatív pedig 111—127 ikra. Összevetve a már több mint 100 éve Európa vizeibe betelepített, naturalizált alohton faj példányait a natív környezetből valókkal, a Holt-Tiszában élő *L. gibbosus* példányok azonos hosszanti növekedése mutatható ki.

Рост и плодовитость Lepomis gibbosus (Pisces, Centrarchidae) в мертвой Тисе (Чуруг — Бисерно Острво)

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Резюме

В течение 1985 г. авторами исследовано 273 особи *L. gibbosus*, пойманных в мертвой Тисе, с точки зрения роста и плодовитости. Средняя длина особей в возрасте 3+—7+ лет составляла 101—146 мм, их масса —48—111 г. Среднее значение абсолютной плодовитости в зависимости от возраста составляло 4474—11 668, а относительной — 111—127 икринок. Сравнивая особей натурализированного в водоемах Европы уже более 100 лет вида алохтон с обитающими в нативной среде, в мертвой Тисе особями *L. gibbosus* была установлена одинаковая степень их продольного роста.

Rast i plodnost Lepomis gibbosus (Pisces: Centrarchidae) u Mrtvoj Tisi (Čurug—Biserno Ostrvo)

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Abstrakt

Analizirani su rast i plodnost *L. gibbosus* u bivšem meandru reke Tise koji je odvojen od rečnog korita sredinom prošlog veka. Unesena u Evropu pre više od 100 godina, ova alohtona vrsta se ubrzo posle introdukcije naturalizovala u ovom delu proširenog areala. Materijal je za ova istraživanja prikupljen tokom 1985. godine. Ukupno je obradjeno 273 primerka uzrasta 3+ do 7+ prosečne standardne dužine 102 do 146 mm i mase tela 48 do 111 g. U poredjenju sa primercima iz nativnog areala, dužinski rast *L. gibbosus* u Mrtvoj Tisi ostvaruje slične vrednosti. Srednja vrednost apsolutne plodnosti se kretala, zavisno od uzrasta, od 4.474 do 11.668 jaja, a relativna od 111 do 127.

Uočava se tendencija porasta apsolutne plodnosti sa povećanjem uzrasta, standardne dužine i mase tela sa značajnom povezanošću, dok relativna plodnost i osnovni biološki parametri ostvaruju neznatnu povezanost.

INCLUSIONS IN THE LIVER CELLS OF SILVER CARP (HYPOPHTHALMICHTHYS MOLITRIX VAL.) FROM THE KISKÖRE STORAGE-LAKE

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Abstract

Annual deaths of silver carps *(Hypophthalmichthys molitrix* VAL.*)* with a body mass of 6—8 kg occur in the spring in the Kisköre storage-lake. In the course of investigations of a weak silver carp specimen no parasites were found which would cause the death of the fish. Sections were pres pared from the interior organs of the fish. In the liver sections a considerable number of inclusion was found in the hepatocytes. The stainability of one bigger or several smaller inclusions according to Masson, with Giemsa or hematoxilin-eosin differed from that of the cytoplasm. The inclusions having mainly spherical shapes were located in the cavities of the cytoplasm. In the liver tissue microscopic necrotic foci were observed as well. It is unlikely that the appearance of inclusions is caused by endogenous degeneration of the cells. According to ANDERSON et *al.* (1965) and MOLNÁR et BOROS (1981) viruses or mycoplasma, as well as clamidia- or rickettsia-like organisms can cause inclusion formation. Striking similarity was found with the observations reported by LANGDON (1988), according to which hepatocyte inclusions have been found in rainbow trout infected by iridovirus.

Introduction

At present silver carp, bighead carp and their hybrids occur already in all natural waters of Hungary as described by BAKOS et al (1979) and MARIÁN et *al.* (1986). Silver carp grows intensively in the Tisza at Kisköre. Its growth is limited by an interesting phenomenon: every year with the increasing of water temperature deaths of a considerable number of silver carps with a body mass of 6—8 kg occur.

The investigation of the causes of the observed event is not easy because of difficulties encountered in catching suitable specimens in natural waters.

Materials and Methods

In May, 1988, we succeeded in catching a specimen from the Kisköre storage-lake. The signs of approaching death were clearly visible: the movement of the fish was slow, the mucous layer of the epithelium was damaged, greyish in colour, at places in tetters.

The specimen was subjected to macroscopic, and subsequently to microscopic investigation. The scrapes collected from the body surface of the fish were studied in native state and impressions were prepared from the internal organs. Liver was fixed in Bouin and formaline, embedded in paraffin and sections were prepared. They were stained with hematoxilin-eosin, Giemsa and according to Masson.

Results

In the course of macroscopic investigations no parasites were osberved which could cause the death of a fish of that size.

In microscopic investigations a considerable amount of bacteria was found in the epithelium, which is natural for the extremely poor condition of the fish. The identification of bacteria was not performed.

Among seemingly healthy viscera our attention was drawn by the liver, which was colourless, on the cut surfaces small cavities were visible. The cavities contained a gaseous substance and liquid, the colour of which corresponded to the colour of the liver. The liver tissue was disintegrating and friable.

The cytoplasm of the hepatocytes in the sections was in general faintly stainable, containing vacuoles. Occasionally, the disorganized cells shrunk, the sinusoides between them becoming broader. On the extended liver tissue surfaces inclusions with a stainability different from that of the cytoplasm could be seen. One bigger or several smaller inclusions, having generally spherical shape were stained in orange-reddish colour by hemotoxilineosin; in case of Masson staining they were usually grey and with Giemsa they were stained in dark blue, sometimes tending to purple, similarly to the nucleolus of the liver cells. Thus, in all cases the inclusions could be easily distinguished in the clearly visible cavities of the cytoplasm. Occasionally, a shiny buble-like formation attached to the spherically shaped inclusion could be observed. The diameter of the shiny buble reached maximally one third of the diameter of the inclusion.

In the liver tissue microscopic necrotic foci were visible as well. In the smaller ones even the contoures of the hepatocytes were recognizable, and in these cell-size cavities cell nucleus clots (?) were found, which in general have similar sizes but differ from each other in shape. The necrotic foci were surrounded by homogenously stainable necrotic cells. At places in the center of the necrotic focus a small gaseous buble was found. In these cases cells and cell nucli floating in liquid could be observed.

Discussion

Data on histological changes as those shown in the figures, description of characteristic hepatocyte inclusions and causes for their appearance are scarce in the literature. It is unlikely that they appear in the cytoplasm as a consequence of endogenous degeneration of the cells. Clamidia-rickettsia-like organisms, viruses, as well as mycoplasma cause formation of inclusions in tissue cultures (ANDERSON et *al.* 1965). According to MOLNÁR and BOROS (1981) the appearance of big inclusions in the gills of silver carp observed in their studies of mucophilosis, can be caused by clamidia-rickettsia-like organisms. PAPERNA et *al.* (1978) reported that clamidia-rickettsia-like organisms caused the appearance of inclusions in the gill tissue of two fish species. Hepatocyte inclusions are discussed by LANGDON (1988). In a paper published in 1986 the author reports on a typical cythophage effect of iridovirus on rainbow trout gonad tissue culture (RTG—2), as well as on the appearance of a roughly spherically shaped, solid nucleoid located in a polyhedral capsule in the infected culture. On the other hand, fish specimens were infected with the virus. Subsequently virus isolation was performed from infected rainbow trout specimens. In the hepatocytes of the sections obtained from infected specimens inclusions were observed (LANGDON 1988), similar to those found in the liver of the silver carp. Since

two different fish species are concerned, we emphasize only the similarity of the histological changes.

Further investigations are necessary to elucidate the causes of the regular spring leaths of silver carps, and to reveal connections between the described changes in, liver and the spring deaths of this species. It is important to clarify the causes for the appearance of inclusions in hepatocytes and the frequency of this phenomenon.

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Zárványok a Kiskörei tározóból származó fehér busa (Hypophthalmichthys molitrix Val.) májsejtjeiben

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Kivonat

A Kiskörei Tározóban évenként előfordul, hogy tavasszal 6—8 kg súlyú fehér busák *(Hypophthalmichthys molitrix* Val.*)* pusztulnak el. Egy gyenge fehér busa vizsgálata során nem találtam olyan parazitát, ami a hal elhullását okozhatná. A belső szervekből metszeteket készítettem. A máj metszeteiben, a hepatocitákban nagy mennyiségű zárványt találtam. Az egy nagyobb v. több kisebb zárvány Masson festéssel, Giemsa-val festve és hematoxilin-eosin festéssel is a citoplazmától eltérő festődésű. A többnyire gömb alakú zárványok a citoplazma üregeiben helyezkednek el. A májszövetben mikroszkopikus méretű nekrotikus gócok is megfigyelhetők. A zárványok nem valószínű, hogy a sejtek endogén degenerációja következtében jöttek létre. ANDERSON és mtsai (1965), MOLNÁR és BOROS (1981) szerint vírusok vagy mikoplazma, ill. clamidia-, rickettsia-szerű élőlények zárványok létrejöttét okozhatják. Feltűnő a hasonlóság LANGDON (1988) által közölt irodalommal, amiben iridovirus fertőzés eredményeképpen találtak pisztrángban hepatocita zárványokat.

Включения, наблюдаемые в клетках печени белого толстолобика (Hypophthalmichthys molitrix val.) из водохранилища в Кишкёре

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Резюме

Весной в водохранилище Кишкёре наблюдается гибель белого толстолобика *(Hypopthalmichthys molitrix* Val.*)* весом в 6—8 кг. При обследовании ослабевшей особи белого толстолобика не было обнаружено паразитов, которые могли бы вызвать гибель рыб. Были приготовлены срезы с внутренних органов особи. В гепатоцитах из срезов печени обнаружено большое количество включений. Наблюдаемые одно большое или несколько меньших включений окрашивали по методу Массона, красителями Гиемса и хематоксилин-эозин, при этом их окраска отличалась от окраски цитоплазмы. Включения, которые в большинстве случаев имели сферическую форму, находились в полостях цитоплазмы. В ткани печени наблюдали также микроскопические центры некроза. Маловероятно, что образование включений вызвано эндогенной дегенерацией клеток. По мнению Андерсона и соавт. (1965) и Молнара и Бороша (1981) вирусы или микоплазма, а также организмы, подобные кламидии или рикеттсии, могут вызвать образование включений. Очевидно большое сходство результатов, полученных в настоящей работе, и данных Лангдона (1988), указывающих на наличие включений в гепатоцитах форели, зараженной иридовирусом.

Kristali u stanicama jetre Hypophthalmichthys molitrix Val. iz rezervoara za vodu Kisköre

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Abstrakt

Svakog proleća se desi da *Hypophthalmichthys molitrix* Val. jedinke od šest-osam kilograma poginu.

Autorica je ispitala jednu slabu jedinku i nije našla parazitu od čega bi riba crknula.

Zato, pravila je preseke od nutarnjih organa.

U stanicama jetre (u hepaocitama) našla je kristale u većim količinama.

Kristali — većeg ili manjeg oblika — se bojadisaju sa Masson-, Giemsa- i sa hematoksilin-eosin bojama. Općenito, kristali su sfernog oblika i nalaze se u šupljinama citoplazme.

Nađeni su nekrolična zarišta u jetri. Čini se da kristali nisu od endogen-degeneracijskog porekla.

Prema ranijim radima Andersona i dr. (1965), Molnara i Boroša (1981) razlozi su sledeći: virus ili mikoplazme, odnosno uzročnici clamidia i rikettsia su sposobni da prouzrokuju nastajanje kristala.

Našla je sličnost sa radom Langdona (1989), koja je našao kristale u hepatocitama pastrmke uzročen sa iridovirusima.

DEMOGRAPHIC ANALYSIS OF THE MOOR FROG (RANA ARVALIS WOLTERSTORFFI FEJÉRVÁRY 1919) POPULATION IN FRAXINO PANNONICAE — ALNETUM OF THE TISZA BASIN

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Abstract

Data of 3355 R. arvalis specimens collected monthly during the whole season in the period between 1984 and 1988 were analyzed. The capture-recapture method was applied on the 2000 m^2 sampling area in the alder forest at Tiszaalpár *(Fraxino pannonicae — Alnetum)*.

A gradual increase in density and biomass was observed in the five-year period (505—9800 specimens/ha, 2—45 kg/ha). The home ranges were small and considerable overlapping were observed. Migration plays a significant role in the summer populating of the Alnetum. The distribution of frogs is random, slightly cumulative, the individuals stick to the ticker vegetation structures surrounding the trees. The survival changed from year to year, a high level of juvenile mortality was observed. Not a single specimen reached the age of 4 years. The growth of body mass is intensive, in two years the specimens raech a body mass of 12—20 g, and become sexually mature. The intraspecific competition exerts a considerable, while the interspecific — only an insignificant effect on the moor frog population.

Preserving the intact state of the Tiszaalpári basin is of a primary importance from the nature conservancy point of view. Except for the maintenance of the favourable water supply, the anthropogenic interference should be eliminated. The *Anura* communities, rich in number of species and individuals, are of a decisive importance for birds (Ciconiiformes) trophically based on them.

Introduction

In the field of ecological research of the Tisza river herpetologic investigations are being carried on since 1984 in the Tiszaalpári basin. The object of investigations was in the first place a forest population of *Rana arvalis*. The aim of the investigations was to elucidate the inherents pace-time pattern of the *R. arvalis* population and to clarify the causal background of the changes occurring in it. The determination of demographically important parameters (density, biomass, population structure, growth, home range size, distribution of individuals, migration) besides its scientific merit serves the purposes of herpetofauna conservation, too.

The data found in the literature concerning *R. arvalis* are well-documented but cover only a narrow range of aspects, e.g. Metelan moor frog symposium held in 1987. In its proceedings detailed studies are found on aquatic habitat and reproduction (CLAUSNITZER 1987, HÜBNER and SENNERT 1987, LOMAN 1987, NÖLLERT 1987), migration (BÜCHS 1987, HELLBERND 1987, HÜBNER and SENNERT 1987) and

growth (van GELDER and WIJNANDS 1987, HÜBNER and SENNERT 1987) of *R. arvalis*. Complex demographic investigations are scarce (e.g. LOMAN 1987), for this reason data of other authors on different frog and lizard species are used in the discussion.

Materials and Methods

The investigations were carried out in the period of full activity between 1984 and 1988 in the area of Tiszaalpár-Tőserdő in the Kiskunság National Park. The alder forest *(Fraxino pannonicae — Alnetum)* is situated lower than its surroundings, and is characterized by a permanently ballanced water supply, its soil is sandy, originating from the Danube—Tisza sediment (BANCSÓ 1987). The forest stand comprises 30—50-year-old *Alnus glutinosa* (L.) GAERTNER, occasionally *Fraxinus angustifolia* ssp. *pannonica* Soó et SIMON specimens occur. From spring till June shallow surface water can cover the ground. Due to favourable water supply during the whole vegetation period no noticable changes in the vegetation character of the herb layer are observed, a considerable accumulation of organic matter occurs (BANCSÓ 1987). The forest borders on the one side cultivable lands, and on the other — marshes and meadows, where the reproduction of *R. arvalis* occur. The invertebrate fauna of the forest is extremely rich in species and is characterized with a high number of individuals (the summer biomass is 6—10 g/m²), thus providing a rich feed supply for the Anura populations.

The long-legged moor frog (*Rana arvalis wolterstorffi* FEJÉRVÁRY 1919) — the dominant *Anura* species in the *Alnetum*, was subjected to a thorough demographic investigation. A species of a broad ecological amplitude, spread mainly in Middle Europe, it is found in various habitats: meadows, forests, reedy — and sedgy marshes, in the vicinity of water (DELY, 1967, GÜNTHER 1985, etc.). *R. arvalis* is a species characterized by a typically terrestrial life form, it seeks water only in the period of laying eggs (MÉHELY 1892, GÜNTHER et *al.* 1969, GLANDT 1986). It is active from March till November, depending on the weather conditions and the northern latitude. Juveniles show diurnal, adults rather nocturnal activity (GÜNTHER et *al.* 1969, GÜNTHER 1985, LOMAN 1987).

The following Amphibia species are wide-spread in the *Alnetum: Bufo bufo* (LINNAEUS 1758) (B=1—5 kg/ha). and *Hyla arborea* (LINNAEUS 1758) (B=2—10 kg/ha). In smaller number of indi-

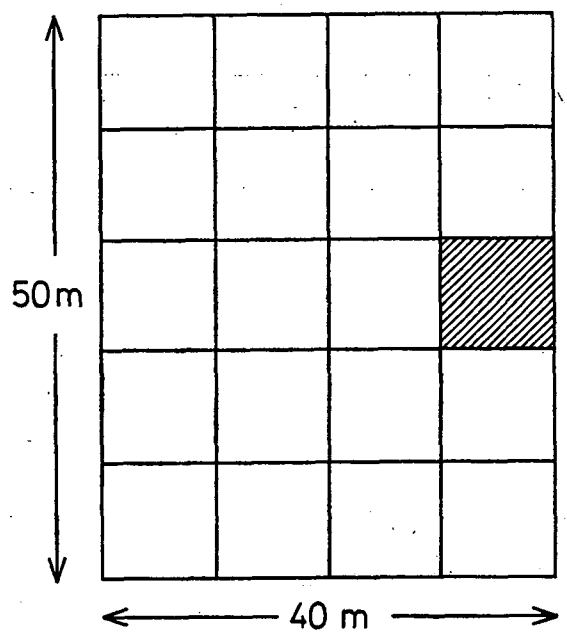

Fig. 1. Schematic map and division of the sampling area (the space coordinates indicated in the 100 m² squares)

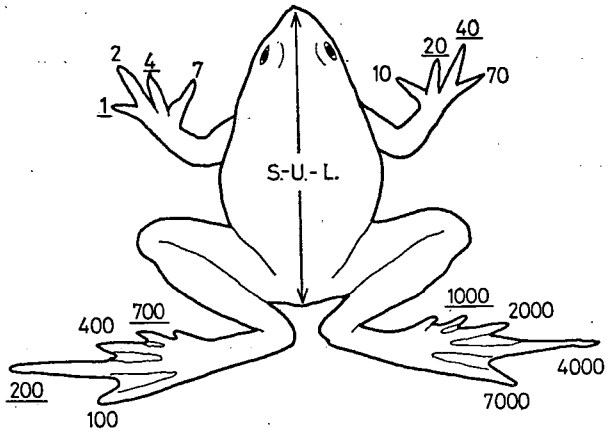

Fig. 2. Individual marking (the numbering of toes from above: e.g. no 1965) and snout-urostyle length of frogs

viduals are found *Triturus vulgaris* (LINNAEUS 1758), *Pelobates fuscus* (LAURENTI 1768), *Bombina bombina* (LINNAEUS 1761), and its green back form, *Rana ridibunda* PALLAS 1771 (4—250 specimens/ha) (GYOVAI 1988).

On the 2000 m² sampling area in *Fraxino pannonicae — Alnetum* numbered boards were placed at distances of 10 m from each other. The area marked by four boards was divided in 100 squares with an area of 1 m² (Fig. 1), in this way the coordinates of the frogs caught could be specified with an accuracy of 1 m and mapped. In the period between 1984 and 1988 from March till November data have been collected monthly by means of the capture-recapture method.

The sampling area or parts of it were systematically and evenly surveyed, applying manual catching. Frogs were individually marked by pinching off various combinations of distal toe phalanges according to the method of WOODBURY (1956) modified by BRUSSARD (1971, cited in SOUTHWOOD 1978) (Fig. 2). The distinction of age-groups and growth sutdies were based on the recapture data. The sex determination, even in adult species, was possible only in spring and autumn on the basis of the big toe and web sizes (MÉHELY 1892, DELY 1967). The snout-urostyle length was determined with an error of 1 mm, and the body weigth was measured on PESOLA spring scales with an error of 0,1 g.

In the five-year period data of 3355 *R. arvalis* specimens have been analyzed. The density and biomass values were determined on the basis of all specimens collected. The home range values were calculated from the average action radius determined from the series of lengths of recapture. The distribution of individuals was calculated on the basis of the closest neighbour method (CLARK and EVANS 1954, cited in SOUTHWOOD 1978).

The age structure was calculated yearly by pooling the autumn (August—October) density values. The agespecific mortality functions were calculated from the same data by exponential fitting in logarithmic form. The growth curves for different age-groups and sex were constructed on the basis of the body mass of the recaptured specimens.

Results and Discussion

1. Density and biomass

The annual density and biomass of *R. arvalis* showed a considerable increase in the period between 1984 and 1988 (Table 1, Fig. 3). The annual maximal values of density and biomass were observed in different months (Table 1). This depends on the effectiveness of reproduction, the time of juvenile metamorphosis and immigration and the annual pattern of mortality. In the beginning of the year the density and

Table 1. *Annual maximal density (D_{max}) and biomass (B_{max}) of R. arvalis population between 1984 and 1988 at Tiszaalpár*

Date	D_{max} [specimens/ha]	B_{max} (g/ha)	sampling area (m^2)	average of the annual coverage with water
1984. (10. 15.)	505,0	2 221,5	2000	90%
1985. (10. 05.)	1533,3	5 370,0	1200	40%
1986. (06. 26.)	3591,6	20 600,8	600	10%
1987. (08. 15.)	8366,6	22 786,6	300	10%
1988. (07. 04.)		44 963,3	300	10%
08. 13.	9800,0		100	10%

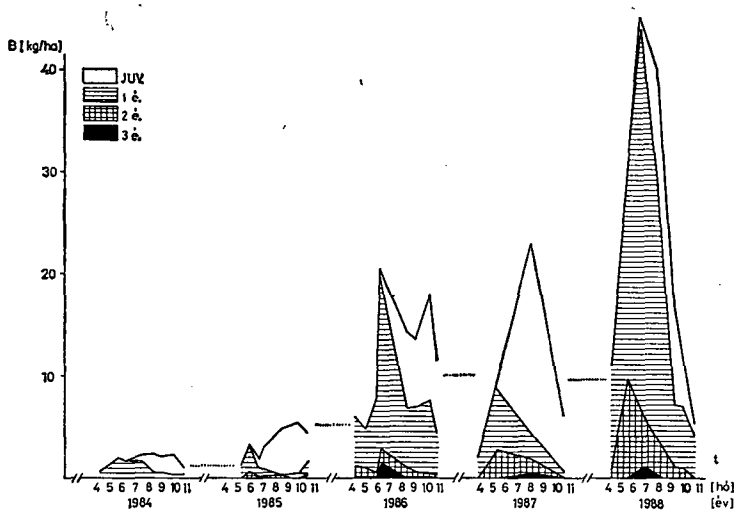

Fig. 3. Biomass of R. arvalis population in different age groups between 1984 and 1988 (... hibernation) 1. year 2. year 3. year [year] [month]

biomass are low, since at that time the adult specimens are either at distant waters where laying of eggs occur, or feeding in the meadows. 20—80% of the ground of *Alnetum* is covered by water till the beginning of summer (May—June). Only after that all the *R. arvalis* specimens return to their terrestrial habitat. The density and biomass of adult specimens are maximal in the beginning of summer (June), decreasing towards autumn, due to continuous mortality, and migration towards the wintering sites. The density of juveniles is maximal in the autumn (August—October), when their metamorphosis and immigration are completed. The values of biomass depend on the density, as well as on the average body mass in different age-groups, these two factor together determine the autumn maximum. In the early autumn the rate of mortality is lower than that of the body mass growth. Similar reasons explain the early autumn maximum observed in the biomass of lizards (TINKLE 1987).

Multiple factors caused the increase in density and biomass observed from year to year. The low density observed in 1984 and 1985 could be connected with the

lowest temperatures measured in March in 1982, 1983 and 1984 ($t_{1982} = -2{,}9$ °C, $t_{1983} = -8{,}6$ °C, $t_{1984} = -8{,}7$ °C, which probably reduced the effectivity of reproduction.

The density depends on the larva survival in the preceeding years (LOMAN 1987). It has been shown that the winter cold has no relevant effect on hibernating specimens.

In 1984 and 1985 practically the whole year round the ground of *Alnetum* has been covered by water, and the majority of *R. arvalis* specimens stayed at the dry areas surrounding the alder trees. In the following years (1986—1988) the underground water-level decreased and the forest ground dried. Although the water cover disappeared, the relative humidity of the air remained high, which provided optimal conditions for *R. arvalis* (HÜBNER and SENNERT 1987).

During dry summers some of the frogs inhabiting the surrounding drying out meadows presumably migrate to the forest having optimal microclimatic conditions and a high relative humidity of the air. *Alnetum* is a habitat with a rich feed supply, its complex vegetation provides protection from predators. In 1987 and 1988 an extremely favourable feed supply was due to the overreproduction of *Melasoma aeneum* and the high abundance of small snails and spiders. 80% of these organisms were consumed by *R. arvalis* (unpublished data). The simultaneous favourable effect of the meteorological and trophic factors led to the appearance of the unprecedentally high for the temperate climate frog density and biomass.

Taking into consideration the estimated density of the coexisting species (*Hyla arborea, Bufo bufo,* etc.) the total density of *Amura* species reached in the autumn of 1988 12 000 specimens/ha. The desnity observed in the alder forest surpassed even that of frogs and lizards living in some rain forests (Table 2). According to SCHOENER and SCHOENER (1980) the maximal desnity of the lizard *Anolis sagrei* found on the Bahama Islands was 9700/ha. Density, besides the quality of the habitat, depends also on the geographic latitude, decreasing in general towards the north, due to the shorter activity period (GYOVAI 1986). In Sweeden the density of *R. arvalis* per ha ranged between 140 and 700 (LOMAN 1987).

Table 2. *Comparison of frog and lizard densities in the forests of the Old and New World*

N latitude place	density (speciemens/ha) frogs	frogs and lizards	reference
14° 30′ Thailnad	12—27	115—149	Inger (1980)
10° 26′ Costa Rica	1470	1750	Scott (1976)
9° Panama	2980	4520	Heatwole and Sexton (1966)
8° 42′ Costa Rica	1160	1550	Scott (1976)
1° 37′ Borneo	131	156	Inger (1980)

2. Home range size

The size of the home range is an ecological category providing information on the competition and density factors affecting the population and on the utilization of resources (TINKLE 1967). In 1986 the area of the circular home range of *R. arvalis* ranged between 15 and 20 m² for juveniles, for adults it was on the average 84,6 m² (females: 47,1 m², males: 159,5 m²). The size of the action area depends on the body

size, for which reason sex-related differences are observed (TINKLE 1967, RUBY 1978, SCHOENER and SCHOENER 1980, CHRISTIAN and WALDSCHMIDT 1984, GYOVAI 1986). In Sweeden the size of the home range of *R. arvalis* was 260 m² (LOMAN 1987). The relatively small home range of the moor frogs found in the *Alnetum* at Tiszaalpár can be explained by the considerable density and high supporting capacity of the forest.

From the reciprocal value of the density it follows that 80—98% of the home ranges overlap, the specimens do not have the territory for their exclusive use. This is to be expected in the cases of high density populations (GYOVAI 1986) and is an indication for a strong intraspecific competition.

On the basis of annual recaptures lasting, usually life-long fidelity and habitat recognition can be demonstrated in adult *R. arvalis* specimens. The adult specimens leave their home ranges every spring but after laying eggs, they return from year to year to their original sites (LOMAN 1987). The pronounced fidelity and habitat recognition was proven in studies on *Atelopus variance* (Bufonidae) by CRUMP (1986) and on lizards (Lacertidae) by STRIJBOSCH et *al.* (1983). The guiding mechanisms of the very precise habitat recognition is still unknown.

3. Migration, colonization

Migration is playing an important role in several aspects of the life of *R. arvalis* population. The larval development and metamorphosis of the moor frog takes place in waters at a considerable distance from the sampling area (200—500 m, $\bar{d}=320$ m). After the metamorphosis is completed a considerable juvenile migration occurs, from the beginning of July mass colonization of the forest is observed. BÜCHS (1987) has proven the existence of three main migration periods for *R. arvalis* (July, August, September). This is related to the non-synchronized metamorphosis taking place from Mid—May till June (HÜBNER and SENNERT 1987). STAMPS (1983) reported on fast populating of the foraging home-sites by juvenile lizards.

The emigration of adult specimens towards waters for laying eggs occurs presumably in spring (GLANDT 1986). The migration of *R. arvalis* does not exceed 600 m, they usually live in the vicinity of waters (HAAPANEN 1970, cited in GLANDT 1986).

Occasionally, the juveniles also leave the *Alnetum* in the cool early spring, and emigrate to the neighbouring warmer meadows and shallow marshes. On March 29, 1986 a migration distance of $57{,}7\pm17{,}8$ m from the sampling area was measured. After the warming up of the ground of *Alnetum* and disappearance of the surface water their return is completed. On a year scale the emigration and immigration are of the same order (BÜCHS 1987, HELLBERND 1987).

4. Distribution of individuals

The monthly distribution of *R. arvalis* individuals as observed in 1984 was — with small deviations — random, slightly cumulative ($\bar{r}^2 \cdot m=0{,}177$—$0{,}282$). The values measured in August in different years were as follows: 1984 — 0,197; 1985 — 0,344; 1986 — 0,391; 1987 — 0,209; 1988 — 0,114. No correlation could be found between the annual changes of the distribution of individuals and the increase in density.

Similar distribution was demonstrated for alder trees in the sampling area. The architecturally complex herbaceous vegetation surrounding the root-head located above the ground level has in fact a relevant effect on the space distribution of frogs. A considerable enrichment of the surroundings of the alder trees with *R. arvalis* specimens is observed. Here their density is 8,99 times higher as compared to the bare, damp or covered with leaf-detritus areas among the trees.

The distribution of forgs is determined basically by the complex structure of the feeding and hiding sites. Such places in general not only help to successfully avoid predators but they are at the same time feed sources (SCHOENER and SCHOENER 1980, STAMPS 1983).

5. Age structure

The age structure of *R. arvalis* population changes from year to year (Fig. 4, Table 3). The annual survival of juveniles — with the exception of 1987 — is low, less than 20%. The major part of juveniles perish in larval stage and during immigration. Presumably, the major factor of mortality is predation which affects in the first place the small body size juveniles. This is supported by the signs of encounters with predators observed in 2% of the juveniles (back injuries, leg loss, etc.). Presumably, an extremely high predators' pressure is exerted on the *R. arvalis* population which ensures a proper regulation of the high density population. High mortality was demonstrated in the period following the birth in *R. temporaria* by SMIRINA (1980).

The chances of adult specimens for survival are better, though not a single specimen reached the age of 4 years. The mortality functions and histograms showed patterns changing from year to year (Fig. 4, Table 3). The potential predators in

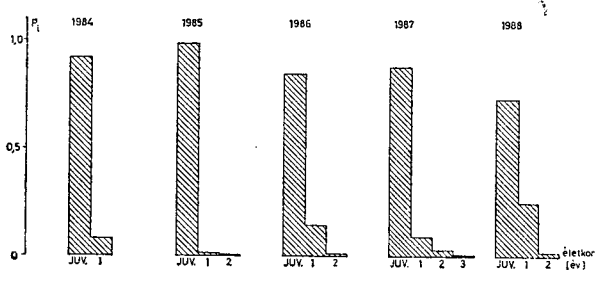

Fig. 4. Age structures of R. arvalis population between 1984 and 1988 year of life [year] [period of life]

Table 3. *Annual age-specific mortality functions of R. arvalis population p_i: relative frequency (in autumn $\Sigma p_i = 1$), t: age in year p: significance (ns — not significant)*

Year	Mortality function	p
1984	$\ln p_i = 1{,}15e^{-2{,}46t}$	ns
1985	$\ln p_i = 0{,}76e^{-2{,}82t}$	$p < 0{,}1$
1986	$\ln p_i = 1{,}14e^{-2{,}28t}$	$p < 0{,}1$
1987	$\ln p_i = 0{,}45e^{-1{,}65t}$	$p < 0{,}02$
1988	$\ln p_i = 0{,}90e^{-1{,}88t}$	ns

Alnetum are: heavy-bodied Carabidae, parasitoid Calliphoridae, *Rana ridibunda* (proven, unpublished), *Natrix natrix, Aves.* In Sweeden the annual survival of *R. arvalis* s higher, annual 60%, predators being the main mortality factor (LOMAN 1987).

In 1984, 1985 and 1986 R. arvalis reached sexual maturity presumably at the age of 2 years. In 1987 and 1988 due to the slower growth probably only a small fraction of 2-year-old and the 3-year-old specimens were involved in the reproduction. In general *R. arvalis* (ssp. *arvalis*) reach sexual maturity at the age of 3 years (GÜNTHER et *al.* 1969, LOMAN 1987), some females even at the age of 4 (LOMAN 1987).

In 1988 the average number of eggs in an egg-clump was 791,6±300,7. The considerable scattering indicates the presence of small and big clumps (450—600 eggs and 1100—1200 eggs). Presumably, the smaller ones were layed by the heavy-bodied (>50 mm) 2-year-old females, whether the bigger ones — by the 3-year-old (>60 mm) females.

In reptilia several authors found a positive correlation between the number of eggs layed and the body size (TINKLE 1972, AVERY 1975, IVERSON 1979, VITT and LACHER 1981, GYOVAI 1986), in *Rana graeca* (BEŠKOV (1970).

6. Growth

The growth of *R. arvalis* specimens is intensive, the age groups are easily distinguished on the basis of body mass (Fig. 5). The growth stops in October — before the hibernation, — the body mass decreases. The growth rate of frogs decreases in function of age (SMIRINA 1980, WHEATER 1985, LOMAN 1987). The body mass growth curves for lizards show a downward tendence and have a sigmoid shape (van DEVENDER 1978, GYOVAI 1986), which in principle is valid for frogs as well. The body mass growth of *R. arvalis* in the sampling area shows a linear tendency, due to the

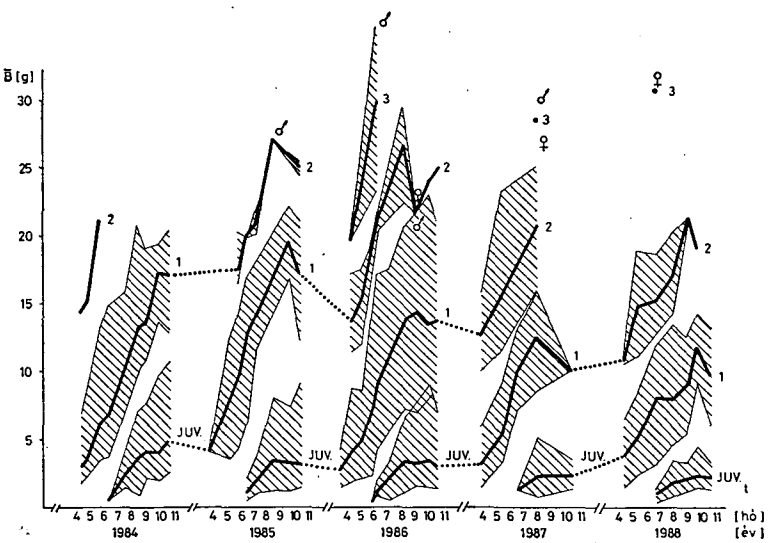

Fig. 5. Average body mass growth in different age groups of R. arvalis population between 1984 and 1988 (heavy line: average values, striped area: minimum-maximum) [month] [year]

fact that the adults perish at the age of 3 years, before reching the potentially maximal (asymptotic) size (Fig. 4,5).

Presumably the density dependent factors controlling the populations (limited resources under the conditions of increasing density) led to the considerable decrease in the growth rate in the period between 1985 and 1988 (Fig. 6). This tendency was particularly pronounced in the one-year-old generation, in which the average values for 1988 were by 40% lower than those for 1985.

The body size segregation within the age groups by means of the continuous resource distribution presumably plays a significant role in minimazing the intraspecific competition (Fig. 5). Positive correlation is observed between the size of feed-animals and the body size (GYOVAI 1988), in lizards (ROSE 1976, PIANKA and HUEY 1978, SCHOENER et *al.* 1982, GYOVAI 1986). In *Rana temporaria* within the same age groups 3,5-fold differences in the body mass have been observed by SMIRINA (1980).

By the method of capture-recapture it was established that the growth of males is more intensive than that of females (Fig. 7). E.g. in 1986 the body mass of one-year-old male reached that of a two-year-old female (Fig. 5). Contrary to these ob-

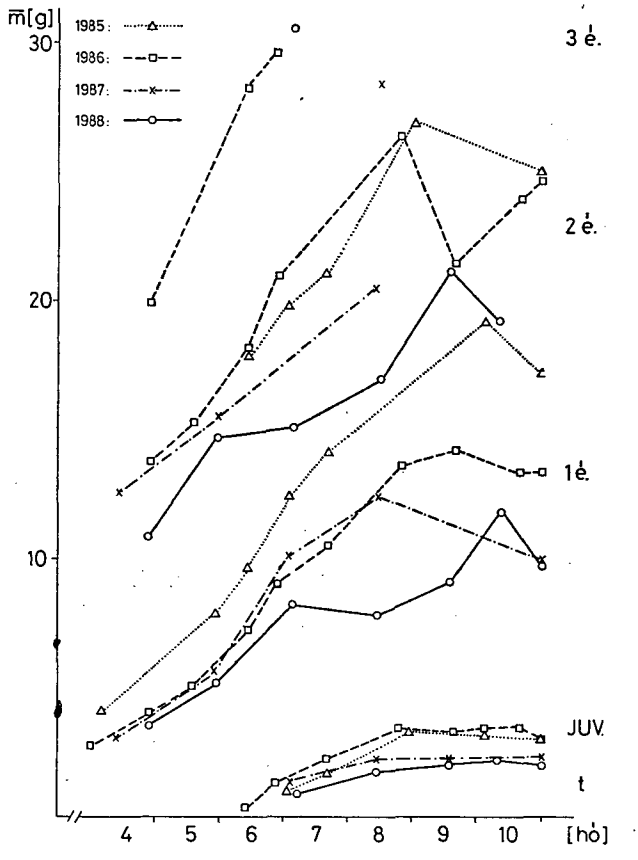

Fig. 6. Changes in the average body mass in different age groups of R. arvalis in 1985—1988
3. year 2. year 1. year [month]

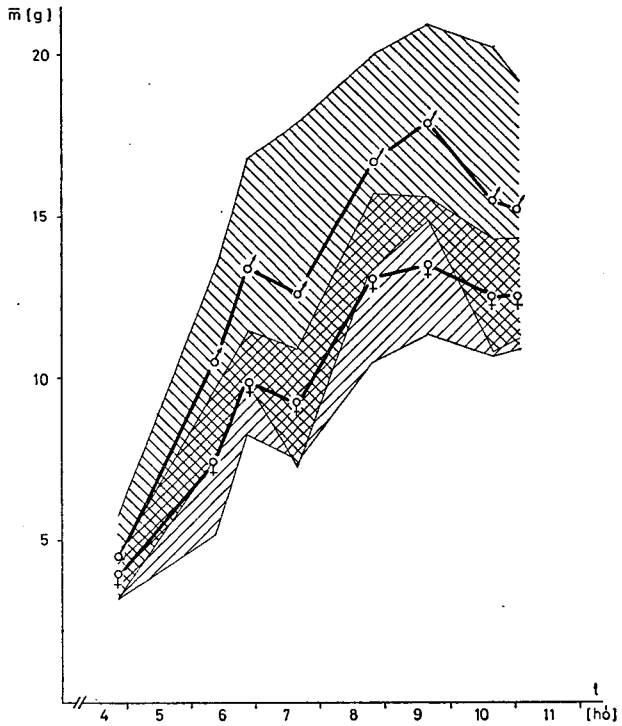

Fig. 7. Sex-dependent average body mass growth of R. arvalis in 1986 (striped areas: scattering) [month]

servations according to the literary data the length and body mass of female frogs exceed that of the males (MÉHELY 1892, GÜNTHER et *al.* 1969, ELMBERG 1987). However, the bigger size of the females could be explained by their higher survival as compared to the males.

The maximal body length of *R. arvalis wolterstorffi* subspecies observed in Hungary is 76,5 mm (DELY 1967). In 1986 in the *Alnetum* at Tiszaalpár the body length and body mass of the biggest three-year-old male found was 70 mm and 35,3 g, respectively; in 1988 the body length and body mass of the biggest three-year-old female measured, respectively, 67 mm and 30,6 g (Fig. 5).

The specimens of the *R. arvalis* arvalis subspecies are shorter but thicker-set as compared to the wolterstorffi subspecies (GÜNTHER et *al* 1969, TOMASIK 1971, HELLBERND 1987, etc.). Their growth is slower (LOMAN 1987) but beside the genetically determined features this can be explained by the shorter vegetation period of the northern habitats as well.

The morphological parameters of the population inhabiting the sampling area are expressed by the relation $m = 5.83 \cdot 10^{-5} \cdot L^{3.107}$ (m — body mass in g, L — body length in mm).

7. Intra- and interspecific competition

Among the specimens of the high density population of *R. arvalis* the competition can develop in the first palce in relation to feeding. The feed size shows a positive coorealtion with the specimens' body length (GYOVAI 1988). The intraspecific interactions within the age groups are significant in the high density juveniles and one-year-old subadults (Fig. 4, 6). The metamorphosis is protracted (from May till June). This is proven as well by the three juvenile migration periods observed (BÜCHS 1987). For these reasons considerable variations are observed in the development and body size of the specimens of different ages and sex. The strong body size segregation of the juveniles and one-year-old specimens (Fig. 5) reduces to a certain extent the strong feed-competition within the age group (wide range of resource utilization).

The intraspecific feeding interactions between juveniles and adults are presumably minimal. This is justified by the segregation of their activity in time and by the insignificant overlapping of feed sizes for different age groups (GYOVAI 1988). The growth of juvenile specimens is regulated by the density dependent intraspecific competition.

Contrary to the coexisting *Anura* populations the interspecific competition for *R. arvalis* is probably minimal, it even could not be demonstrated. *R. arvalis* is vertically segregated from *Hyla arborea* characterized by arboreal life form. Effective interspecific competition with *Bufo bufo* and *Pelobates fuscus,* species characterized by nocturnal life form and passive prey-capture strategy, is presumably minimal, too.

8. Nature conservancy aspects

R. arvalis characterized by a broad ecological amplitude is at present a general frog species in Hungary. However, in a number of places in Western Europe it is endangered by extinction and its short-legged subspecies *(Rana arvalis arvalis)* is on the red list (HÖLZINGER 1987, HÜBNER and SENNERT 1987). As far as its aquatic habitat is concerned it is a stenök species, for its development it requires shallow, oligotrophic moor (HÜBNER and SENNERT 1987). Among the endangering factors the water acidification (CLAUSNITZER 1987) and the enrichment, even shading of the coast structure (NÖLLERT 1987) can be mentioned. *Anura* is endangered by the application of pesticides and intensive agriculture (HÖLZINGER 1987). E.g. in the case of lizards seemingly insignificant changes in the original vegetation can lead to drastic changes (GYOVAI 1986).

The herpetofauna in the Tiszaalpár basin is exceptionally rich, both quantitatively and qualitatively, which indicates at present it intact state. The vegetation, microclimatic and trophic conditions of *Alnetum* are favourable for the *Anura* populations. The frogs developing in the neiboughring marshes are of decisive importance as a trophic basis for the Ciconiiformes (*Ardeola ralloides, Egretta garzetta, Platalea leucorodia,* etc.), which represent the high nature conservancy value of the region.

The high density *R. arvalis* population in the *Alnetum* serves as a species reservoir. The maintenance of such a stable habitat is justified both from the nature conservancy and forestry point of view. In the future, except for providing an optimal water supply, the region should be protected from any other anthropogenic effect. By keeping the state of the Tiszaalpár region close to natural, one of the most valuable *Anura* habitat in Middle Europe should be by all means preserved.

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Mocsári béka (Rana arvalis wolterstorffi Fejérváry, 1919) populáció demográfiai analízise a Tiszavölgy Fraxino pannonicae-Alnetumában

GYOVAI F.

Kivonat

Az 1984—1988 évek teljes szezonjára kiterjedő havonkénti gyűjtések során 3355 R. arvalis egyed adatai lettek feldolgozva. A tiszaalpári éger erdőben *(Fraxino pannonicae-Alnetum)* kijelölt 2000 m²-es mintaterületen a jelölésvisszafogás módszer volt alkalmazva.

A denzitás- és biomassza értékek folyamatos növekedést mutattak az 5 év során (505—9800 egyed per hektár, 2—45 kg per hektár). A home range méretek kicsik és nagy átfedéseket mutatnak. Az *Alnetum* nyári benépesülésében a migráció nagy szerepet tölt be. A békák diszpergáltsága random kissé kumulálódó, az egyedek kötődnek a fákat övező vegetációs struktúrákhoz. A túlélés évről évre változott,a juvenilisek mortalitása nagyfokú. A 4 éves kort egyetlen egyed sem érte meg. A testsúly növekedés igen intenzív, az egyedek két év alatt elérik a 12—20 grammos testsúlyt és ivaréretté válnak. Az intraspecifikus kompetíció jelentős, az interspecifikus azonban jelentéktelen hatást gyakorol a mocsári béka populációra.

Természetvédelmi szempontból elsődleges a tiszaalpári medence érintetlenségének biztosítása. Az optimális vízviszonyok fenntartásán kívül az antropogén beavatkozásokat meg kell akadályozni. A páratlanul gazdag faj- és egyedszámú *Anura* közösségek a trófikusan rájuk épülő madarak (Ciconiiformes) számára kulcsfontosságúak.

Демографический анализ популяций болотной лягушки (Rana arvalis wolterstorffi Fejérváry, 1919) в ольховом лесу Тисаалпари Fraxino pannonicae-Alnetum

Ф. Дьоваи

Резюме

Обработаны данные 3355 особей *R. arvalis*, пойманных в результате ежемесячного сбора образцов, распространяющегося на весь сезон в период 1984—1988 гг. В ольховом лесу у Тисаалпари *(Fraxino pannonicae — Alnetum)* на изучаемом участке прлощадью в 2000 м² применяли метод маркирования и исследования вновь пойманных особей.

За пятилетний период наблюдалось постоянное увеличение плотности и биомассы (505—9800 инд га, 2—45 кг/га). Размеры областей обитания особей были невелики и наблюдалось их значительное перекрывание. В летнем заселении *Alnetum*-а миграция играет значительную роль. Распределение лягушек беспорядочно, с известной тенденцией кумуляции; особей привлекают густые растительные структуры, окружающие деревья. Выживание менялось из года в год, гибель молоди была значительной. Ни одна из особей не достигла возраста 4 лет. Увеличение массы весьма интенсивно. Масса особей за два года увеличивается до 12—20 г и они достигают половой зрелости. Внутривидовая конкуренция имеет значительное, в то время как междувидовая — лишь незначительное влияние на популяцию болотной лягушки.

С точки зрения охраны окружающей среды важно сохранить заповедность бассейна Тисаалпари. Кроме обеспечения благоприятного водного режима следует исключить все другие антропогенные влияния. Сообщества *Anura*, отличающиеся исключительным богатством видов и числа особей, играет решающую роль для птиц *Ciciniiformes*,, являясь их трофическим базисом.

Demografijsko izučenje populacije Rana arvalis wolterstorffi (Fejérváry, 1919) u šumskoj zajednici Fraxino pannonicae-Alnetum

GYOVAI F.

Abstrakt

Sa mjesečnom skupljanjem autor je obradio podatke od 3355 primeraka Rana arvalis u periodu 1984—1988 god. Metoda „označavanje-ponovno hvatanje" je bila primjenjena u zajednici *Fraxino pannonicae-Alnetum* na teritoriji od 2000 m²-a.

Tokom ove pet godine denzitet i biomasa su se stalno uvećavali (505—9800 primerak kroz hektara, 2—45 kg kroz hektara).

„Home range" razmerke su bile male i pokazali su velike preklapanje. U letnjoj naselji *Alnetum,* migracija je imala velikog značaja.

Disperzitet žabe je bio random, malo kumuliran, jedinke su se jako vezali za vegetaciju.

Svake godine se promenio procjenat preživljenja, mortalitet, juvenilnim jedinkama je bila dosta velika.

Nijedna žaba nije dostigao četvrtu godinu. Povećanje tjelesne težine je bilo intenzivno, jedinci su postigli 12—20 grama preko dvije godine i postali su spolno zrijeli.

Intraspecifična kompeticija ima veliki ali interspecifična kompeticija nema značajniji utjecaj za populaciju Rana arvalis.

Za zaštitu prirode je primarna metoda da bazen kod Tisaalpara da bude netaknuta.

Optimalni vodeni balans da bude održana i ukinuti antropološke utjecaje.

Retko obogaćena fauna *Aure* je neophodna za zajednicu Ciconiiformes.

METHOD FOR ASSESSMENT OF DIFFERENT TERRITORIES FROM THE NATURE CONSERVATION POINT OF VIEW

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Abstract

The author suggests a method for assessment of distinct territories — protected and non-protected — from the nature conservation point of view. In the course of investigations the following conclusions have been drawn:

1. It is indispensable to have a quick method for assessment which counts with the realities and is applicable in practice to different territories
2. For the sake of completeness it is necessary besides the botanical evalutation method which has been worked out previously to have a zoological method for assessment as well
3. For this purpouse different animal groups can come into consideration — e.g. snails, articulates and vertebrates. In the present paper a method using birds has been elaborated
4. It appeares that the best approach is to sum up the products of multiplication of the points assigned to every distinct species according to their value category from the nature conservation point of view by the number of individuals. The results obtained by this procedure — i.e. taking into consideration the abundancy, give a better approximation of the actual values and at the same time show tendencies similar to those obtained by other methods.

Introduction

Nowadays the world around us undergoes ever faster changes which lead to a drastic decrease of the territories preseving their original or close to natural state. Gradually vanish those places which rendered possible the observation and investigation of the processes taking place in nature. This justifies ensuring of increased protection of natural or close to natural territories, turinig them into nature conservation areas. Thos familiar with the procedure of establishment and maintenance of conservation areas are aware of the vast number of questions to be answered in this respect in practice. E.g. justification of establishment of nature conservation area and the level of protection to be introduced, degree of deterioration of the area, tendencies showing after the establishment and treatment of the conservation area,

The answers to these questions are of a primary importance, since they determine the strategy and tactics of nature conservation. For this purpose a method has been worked out by SIMON (1984, 1988) for assessment of vegetation. From publications and numerous lectures dealing with this method it can be concluded that it is suitable for practical applications, though— which coincides with the author's oppinion as well — in addition to the assessment of vegetation it should be supplemented with similar studies of fauna, too. These considerations led to the elaboration of the method described below.

Materials and Methods

The starting point in the present work was the necessity to select for fauna studies an appropriate group of animals which can be found in every or at least in the majority of habitats. In this way it will be suitable for assessment of both terrestrial and aquatic locations. Various vertebrate, articulate and mollusc taxons satisfy the above requirements. Birds seemed to be suitable for this purpouse, too, and were chosen as a basis for the assessment method. It should be emphasized that for obtaining of reliable results it is desirable to carry out similar studies on other groups as well — mammals, fish, snails, articulates. The method was worked out on the basis of assessment of 346 species following the works of KEVE (1984) and HARASZTHY (1984, 1988).

Results

As a first step every representative of the ornithofauna in Hungary is to be assigned to one of the nature conservation value categories defined in advance. The following species categories are suggested:

1. Endemic species — the only Hungarian indigenous species — short toed lark (*Calandrella brachydactyla hungarica* HORVÁTH) was assigned to this category, irrespective of the fact that it is under special protection. Sign: ES
2. Highly protected species — particularly endangered species in Hungary, nesting mainly in small populations, highly protected. Number of species: 29. Sigh HPS.
3. Rare nesting species — those species are assigned to this category which hatch regularly in Hungary, though for some reasons in small number of individuals. However, they do not enjoy special protection. E.g. *Anas acuta, Tyto alba, Parus cristatus,* etc. Number of species: 45. Sign RN.
4. The hatching species the range of which crosses the territory of Hungary. Naturally, they are represented mainly as small number populations in the Hungarian ornis. Since their occurrence is of zoogeographical importance they are assigned to a special category. E.g. *Falco vespertinus, Luscinia luscinia, Lanius senator,* etc. Number of species: 10. Sign RS.
5. Natural species — natural species forming bird associations which are typically nesting in a given habitat. More than half of the bird species in Hungary belong to this category.Number of species: 117. Sign NS.
6. Highly protected migrating species — to this category belong species which do not nest on the territory of Hungary but are regular migrants spending here longer or shorter periods, highly endangered species, being under special protection in Hungary. E.g. *Pandion habiaetus, Falco peregrinus.* Number of species 2. Sign HPM.
7. Very rare visitors — to this category are assigned species observed in Hungary only on few occasions. Their appearance is accidental, number of individuals — low. Normally only single occurences. E. g. *Bubulcus ibis, Surnia ulula, Lanius schach,* etc. Number of species 43. Sign VRV.
8. Rare visitors — those species which winter or migrate more or less regularly through the territory of Hungary, though always in small number of individuals. E.g. *Podiceps auritus, Pelecanus crispus, Gyps fulvus, Nyctea scandiaca,* etc. Number of species 37. Sign RV.
9. Common migrants — here belong those species migrating through Hungary, the appearance of which is regular, though not always in high numbers but not rare. These species form the basis of the spring and winter migration and represent the majority of the wintering species. Number of species: 32, Sign CM.

Naturally these categories cannot be considered as final and closed ones, since the species assigned to different categories and their numbers can change on the one hand as a consequence of changes in fauna, and on the other hand because of alterations in nature conservation regulations.

The assessment of different categories from the nature conservation point of view is possible only if the introduced categories, and the bird species belonging to them are numerically characterized by appropriate point values. This constitutes the basis for all further calculations. Similarly to the approach of T. SIMON the following point numbers were suggested for the categories specified above: CM: 1, RV: 2, VRV: 4, HPM: 8, NS: 16, RS: 32, RN: 64, HPS: 128, ES: 256

The exponentially increasing point numbers adequately reflect the nature conservation importance of bird species assigned to different categories.

In the assessment method worked out for birds it seems justified to take into consideration not simply the presence of different sepcies by summing up the assigned point numbers but rather to weight them with the abundancy or dominance. The following three possibilities were considered:

1. The point numbers assigned to different species according to the category they belong to, were multiplied by the actual number of individuals and the products were summed up to obtain the values characteristics of the territory. This- and only this! — method would have been adequate, if the territories to be studied and compared were of identical sizes. However, this is not the case in the practice. Naturally, larger territories have higher abundancy, and thus the final value will be significantly higher, too. Although this approach reflects the real value of the territory but the comparison with other territories is difficult, and the application of this method — problematic.
2. A second solution could be to sum up the products of multiplication of point numbers of the species according to their category by the individual dominance. Since the dominance is a relative number the comparison of territories of different sizes becomes possible. However, a problem arises in cases when the number of species and individuals on a given territory is low, thus for certain species extremely high dominance values are obtained which leads to abnormally high products, too. Thus, too high point number is assigned to the territory which does not reflect its real value.
3. The third possibility is to sum up the point numbers of the species according to their categories irresective of the number of individuals or dominance. In this, way, the abundancy which reflects the territories' dissimilarity is not taken into consideration but the results of the calculations seem to reflect satisfactory the real values of different areas.

In this case also a comparison of territories of different sizes could lead to certain discrepancies, since with the increase of the territory, a higher number of species can be expected, too. This, however, is valid only in a certain interval, since the increase in size above certain level already does not result in a significant increase of the number of new species. This effect can be most clearly illustrated by comparison of a national park with a small reserve. The difference is striking, which, however, is understandable taking in consideration the different values they represent from the nature conservation point of view.

On the basis of the final point numbers the territories can be categorized to simplify the practical application of the method. The following categories can be distinguished:

I. Exeptionally valuable territory from the ornithological point of view. Point numbers calculated according to
Method 1. 20001 —
Method 3. 2001 —

II. Very valuable territory from the ornithological point of view. Point numbers calculated according to:
Method 1. 15001 — 20000
Method 3. 1501 — 2000

III. Valuable territory from the ornithological point of view. Point numbers calculated according to:
Method 1. 10001 — 15000
Method 3. 1001 — 1500

IV. Territory worth protection from the ornithological point of view. Point numbers calculated according to:
Method 1. 5001 — 10000
Method 3. 501 — 1000

V. Indifferent territory from the ornithological point of view. Point numbers calculated according to:
Method 1. 0 — 5000
Method 3. 0 — 500

This system of classification has been completed on the basis of studies and assessment of nesting fauna in different protected and non-protected territories. It should be taken into consideration that in most of the cases the nesting species play a decisive role in the life of a given territory, for which reason the majority of the data published in ornithological studies deal with these species. Consequently, in these cases better assessment can be carried out. Naturally, this does not mean that — when available — data on migration of species, e.g. resting places of migrating bird flocks, were not taken into cosideration. For this reason special categories are forseen to which migrating, visitor species can be assigned. This will lead, however, to a significant increase of the point numbers, so it is advisible to broaden the point ranges characterizing different territoreis.

The suggested system of assessment serves the needs of nature conservation. In this field it is indispensable to estimate the value of a given territory from the nature conservation point of view, its closeness to the natural conditions, which should be expressed by the calculated final point numbers. However, when drawing conclusions and making value estimations one should not forget that the method is based only on ornithological observations. For these reasons the low or relatively low values obtained from calculations do not necessarily mean that the territory in question is not valuable, since from botanical or zoological (based on different animal group) point of view it might be an exeptionally valuable and important one. As an example low values characterizing Sas Hill and Mohos Lake at Kállósemjén can be pointed out (Table 1). For this reason it is desirable in assessment of territories to take into consideration various aspects of the problem.

The suggested methods were applied for assessment of several territories, the results of which are given in Table 1.

Upon comparison of the data on different territories a question arises which factors influence the appearance of high or low values. If the number of species assigned to different categories — species groups — of a given region are represented as a column diagram, it is clearly seen that the calculated nature conservation values

Table 1. *Nature conservation point numbers of the investigated territories based on nesting species*

Territory	Method 1. Value	Method 1. Category	Method 3. Value	Method 3. Category
1. Tiszavasvári castle forest				
2. Bátorliget-marsh				
3. Tiszadob 50 years' oak-forest				
4. Tiszadob 150 years' oak-forest				
5. Tiszadob acacia grove				
6. Mohos Lake at Kállósemjén				
7. White-halomorphic area at Tiszavasvári		1961		
8.		1968		
9.		1975		
10.		1976		
11.		1984		
12. Rakamaz flood meadow				
13. Tiszalök flood meadow				
14. Palmaliget forestbelt at Tiszavasvári				
15. Dankó poplar grove at Tiszavasvári				
16. Tedej 2nd forest belt at Hajdúnánás				
17. Hajdúnánás grazing forest belt				
18. Királytelek alley at Tiszavasvári				
19. Highway resting place alley at Tiszavasvári				
20. Karámos alley at Tiszavasvári				
21. Hajdúnánás highway				
22. Peszer forest				
23. Conservation area of Badacsony				
24. White Lake at Kardoskút				
25. Pély Bird Sanctuary				
26. Pusztaszer nature reserve				
27. Sas Hill				
28. Conservation area at Szabadkígyós				

are directly proportional to the number of observed categories and species and individuals belonging to them.

Summarizing it can be stated that:

1. It is indispensable to have a quick method for assessment which counts with the realities and is applicable in practice to different territories
2. For the sake of completeness it is necessary besides the botanical evaluation method which has been worked out previously to have a zoological method for assessment as well
3. For this purpouse different animal groups can come into consideration. In the present paper a method using birds has been elaborated
4. It appears that the best approach is to sum up the products of multiplication of the points assigned to every distinct species according to their value category from the nature conservation point of view by the number of individuals. The results obtained by this procedure — i.e. taking into consideration the abundancy, give a better approximation of the actual values and at the same time show tendencies similar to those obtained by other methods .

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Különböző területek természetvédelmi értékelésének egy módja

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Kivonat

A szerző különböző területek természetvédelmi értékelésének egy módját dolgozta ki konkrét — védett és nem védett — területek elemzése kapcsán. Ennek során megállapítható:

1. A különböző területek gyakorlatban felhasználható, gyors és a realitásokat kifejező értékelésére szükség van.
2. A teljesség igénye szükségessé teszi a korábban kidolgozott botanikai értékelési módszer mellett a zoológiai értékelés kialakítását is.
3. A fentiekre különböző állatcsoportok is alkalmasak — pl. csigák, különböző ízeltlábúak és gerincesek. Jelen dolgozatban a madarakkal végzett értékelés módszerét dolgoztam ki.
4. Úgy tűnik, hogy a legalkalmasabb módszer az egyes fajok természetvédelmi-érték kategória szerinti pontértékeinek az egyedszámmal szorozott összegzése. Annál is inkább, mert így — abundancia felhasználásával — jobban közelítünk a reális értékekhez, ugyanakkor — mint azt az 1. sz. ábra is mutatja — a kapott eredmények tendenciája hasonló a másik módszer nyújtotta eredményekhez.

Метод оценки территорий с точки зрения охраны окружающей среды

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Резюме

Автором разработан метод оценки территорий с точки зрения охраны окружающей среды на примере исследования конкретных — заповедных и незаповедных — территорий. Сделаны следующие выводы:

1. Существует необходимость в применимом на практике, быстром и отражающем реальность методе оценки территорий.
2. В интересах более полного описания необходимо дополнить разработанный ранее ботанический метод также зоологическим методом оценки.
3. Для создания такого метода могут быть использованы разные группы животных — например, улитки, членистоногие, позвоночные. В настоящей статье разработан метод оценки, основывающийся на результатах исследований на птицах.
4. Повидимому самым адекватным является метод, принимающий за основу оценки сумму произведений численного выражения ценности данного вида с точки зрения защиты окружающей среды, умноженного на число особей. При этом подходе, с одной стороны, путем учета распространенности видов осуществляется лучшая апроксимация реальных ценностей а с другой — как следует из рис. 1, тенденция полученных результатов совпадает с данными других методов.

Jedna metoda za procenjivanje različite teritorije u smislu zaštita prirode

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Abstrakt

Autor je izradio jednu novu metodu za procenjivanje različite teritorije s pomoću konkretnom analizom prirodnozaštitne i nezaštitne teritorije.

Zaključći su sledeći:

1. Potrebno je brza ali realna procena koja se dobro može upotrebiti u praksi
2. S zahtevom potpunosti pored već osnovane metode za botaničku procenjivanju potrebno je procena i za zoologiju.
3. Za ovu procenu pogodne su više vrsta životinja npr, puževi, različiti zglavkari i kraličnjaci. Autor je izradio zoološko procenjivanje sa pticama.
4. Najpogodnija metoda je sledeća:
   Množiti bodove vrednosti „prirodno-zaštitne-kategorije" sa brojom jedinki.
   S upotrebom abundancije više se može dostići realne vrednosti dok — kao što i 1. slika pokazuje-tendencija dobivenih rezultata je slična rezultatima one druge metode.

FROM THE LIFE OF TISZA-RESEARCH WORKING COMMITTEE
TISZA RESEARCH CONFERENCE XIX (1988)

Compiled by
GY. BODROGKÖZY
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The members of our work-group work in different towns in the river Tisza region. For this reason it was deemed desirable to organize the regular meeting in this year, too. In this way researchers working on different ecosystems can exchange information on the latest results, thus facilitating the realization of the complex research programme. The conference was held on 24—25 November 1988 in the building of the Szeged Committee of the Hungarian Academy of Sciences. In the course of a two-days' sitting lecture were followed by active discussions. Hereby the participants obtained an overall picture of the Tisza region from the source to the mouth. In his opening speech the honorary president of the work-group provessor Benedeczky pointed out the importance of research of the Tisza region on an international level. The president emphasized the possibilities of utilization of the result obtained in these studies in environment and nature conservation. Long term research programmes make possible the control of the changes occuring in the Tisza river region in respect to environmental biology and biocenology. The reports can be arranged in three main groups:

1. Lectures on the Soviet region of river Tisza

MEZŐ-KRICSFALUSHY G., KRICSFALUSHY G. M. and KOMMENDAR V. I.:

The analysis of complex population in *Ornithogallum umbellatum* L. (Liliaceae).

In the course of their investigations the authors have studied the community relations, the yield of phytomass and the optimal environmental biology requirements of *Ornithogallum umbellatum.* Answer was given to the question concerning the different tent of changes caused by antropogen effects in mass relations. Parallel to this, data were obtained about the aftermath of other abiotic and biotic stress effects. On the basis of experimental result, methods were developed which could ensure the protection of Ornithogalum umbellatum in Sub-Carpathia.

FODOR I.

Possibilities for the retention of rainwater along the upper region of the river Tisza

In Sub-Carpathia experiments have been carried out a long time to solve the retention of rain-water by forestation in the areas above the timber-line in the bare forests of the North Eastern Carpathians.

Experiments for the replacement by forestation demonstrated that they could be effective in spite of soil erosion that took place after cutting of timber.

These stands could have a beneficial influence trough their water storage and water-retention capacities on the regulation of water flow rate of the rivers in the plains, ergo flood-disasters could be prevented.

2. Lectures on the Hungarian region of the river Tisza

A. SZITÓ and P. BOTOS

Analysis of the longitudinal section of river Tisza in 1986 Deposit-fauna

Water samples were collected at 38 cross-sections along the Hungarian region of river Tisza and the mouth regions of the tributaries (at distances 500—800 m from the mouth) between September 15 and 30. The selection and conservation were performed on the spot, and the analyses were carried out in the laboratory. The data indicate that the abundance of Oligochaetes above Szamos is still low but the values obtained below Szamos are 2—10 times higher than those obtained previously. The number of individuals of Chironomidae mosquito larvas increased even to a higher degree.

Markedly increased the number of species and individuals of backwater animals *(Polipedilum bicrenatum, P. nubeculosum, Chinonomus semireductus Ch. plomosus, Einfeldia* species*)*. The increase in the number of Oligochaes and Chiromids individuals undoubtedly stimulated by the low water level lasting for years. It can be considered as an extreme case that species normally living on the bank can be found in a great number even in the current deposit.

The number of individuals of shell-fish and snails has decreased significantly. It is particularly conspicuous in the vicinity of larger settlements and towns. In 1979 crawfish *(Astus astacus)* could be found in several sections but at present not a single specimen could be found.

Among theaffluents only the effect of Maros could be demonstrated.

J. WAIJANDT

Effect of Szolnok waste-water on the quality of Tisza water

The middle reaches of Tisza suffer a significant pollution only at Szolnok. Characteristic improvement of water quality is observed between the mouth of Sajó and Szolnok. Tisza is beeing significantly polluted at Szolnok by 5 industrial and 4 habitional sources of different waste-water quality and quantity.

Both of the volume released waste-water and the loading of individual components of waste materials showed a slight increase between 1977—1987. In the course of the approximately 100 days' period of sugar manifcature, the Szolnok Sugar Factory discharges into the river Tisza nearly half of the organic-matter. The major part of washing ingredients, ammonium ions, fats, oils comes from housing astates.

The estimated effect of pollution on the water quality of Tisza is worth mentioning only in the period of sugar-making (between September and December).

Therefore, the impairment of water quality was investigated in details only in this period. As the presence of organic matter, dissolved oxygen and phosphate ions are conserned the impairment of water quality became clearly visible from comparisons of water quality of the sections above Szolnok and at Tiszaug. (Minimum, max num, mean values, statistical curves). The impairment of water quality was of a a lower degree than the calculated one, due to the self-purification of the river, and none of the quality components reached values indicating change in the grade of water quality.

I. Bancsi and Katalin Zsuga

Investigation of zooplankton in the area of the Kisköre storage-lake

Kisköre Barrage was put into operation in December 1973 followed by a gradual flooding of the storage-lake. In the course of the following 15 years considerable changes took place in the surroundings of this area. As a result of the flooding and the 89.30 nation-wide level damming areas with different qualities came into existance in a region of 90 km^2. In our lecture using the results of the 1986 experiments we report on the composition of zeoplankton in different water territories.

The wild-life of Tisza is highly reactive to the changes of water regime. The quality and quantity composition of Zooplankton stock depends on the duration of daming.

On the reach below the barrage a reduction in the number of individuals and species can be observed. Among large water territories the fauna of Abádszalók cove most closely resembles the Tisza fauna. In the wild-life of Sarud basin the proportion of backwater organisms is also considerable. In various territories of Poroszló basin rich Zooplankton association can be found. In the Tiszavalk basin besides planktonic both benthos and metaphyton associations are present due to the shallow water. The presence of river water, backwater and beach region organisms is also characteristic for the Tiszafüred Dead Tisza area. In the Tiszafüred Dead Tisza the Rotaria stock, in the Poroszló basin the Cladocera stock were most abundant in 1986. Planktons of wheel animalcules and crustaceans in Eger brook were present in large quantities because of rich nutrition available all year round. Dominant elements in the region of Kisköre Storage-lake are the members of Rotaria, Brochionus, Keratella, Polyarthra and Synchaeta genus.

Among Cladoceras *Bosnia longirostris* and *Daphnia cucullata* are the most characteristic species but the increasing spreading of *Leptodora kindtii* is worth mentioning. Among Copepoda organisms the rate of forms of nauplius and copepoid is the highest and the number of developed organisms is relatively low.

I. BANCSI

The Mollusca fauna of the benthos of Tisza and its afluant rivers and Kisköre storage-lake

This lectures summarizes the results of the 1986 malacological investigations in the longitudinal sections of Tisza in the territory of Kisköre storage-lake.

Along the Hungarian reach of Tisza 38 sections were tested. Samples were taken from 3 places of each section (left bank, right bank, drift line). The results of the investigations are discussed. In the mentioned territories 22 resp. 20 Mollusca species were found in the deposit.

The Hungarian reach of Tisza is characterized by domination of 2 species of snails *(Lithoglyphus naticoides* and *Valvata naticina)* as well as ofone species of shell-fish *(Pisidum amnicum). Lithoglyphus naticoides* belonged to the dominant species of Tisza even in the previous years but *Valvata naticina* was considered as a rarity. The dominance of *Pisidum amnicum* increased. The *Unio* species were also present in larger number of individuals as compared to the previous years.

In Kisköre area the most frequent snails were *Valvata piscinalis, Valvata naticina,* as well as *Lithoglyphus naticoides* wether the shell-fish were represented in large quantities by *Dreissena polymorpha.*

Valvata piscinalis can be found in considerable quantities in the basins of the storage-lake whether a great number of *Valvata naticina* is to be found in Tisza and in water territories connected with Tisza.

Both *Lithoglyphus naticoides* as well as *Dreissena polymorpha* passage shell-fish are wide-spread in the area of the storage lake. The member of the individuals of *Unio* species similarly to *Anodonta ametina* was lower than it has been expected.

ERZSÉBET SZNÉ. MALIK

One of the presumable reasons of the death of silver carps *(Hypophthalmichthys molitrix* VAL*) occuring in river Tisza in spring*

In spring deaths of silver carps has occured regularly in river Tisza and Körös for several years.

After excisions of a weakened silver carp I observed well distinguishable cell inclusions.

After a detail ed examination I reached the conclusion that it could not be a parasite. In the literature I found only one report on a similar lesion (LANGDON 1988).

In that case similar inclusions caused by iridovirus have been found in the liver of a rainbow trout. Longer time is necessary to find out the reasons of death. My lecture shows only one case which is interesting in the fish pathology, which has not been revealed as yet, but it could be one of the reasons responsible for deaths in spring.

I. Benedeczky and J. Nemcsók

Electron microscopic investigation on liver and pancreas tissues of phenol-treated carps

The effect of 5 ml/l sublethal dose of phenol was investigated on liver and pancreas of carp.

The quantity of glycogen in the cytoplasm decreased 24 hours after treatment. In this manner electron permeable light areas developed. The apparence of cells containing two nuclei was also a striking feature.

Alterations of the nuclei could be observed even in the 48th, 72th and 96th hours after the treatment.

Signs suggesting amitoses, furthermore ultrastructural changes abnormally influencing the metabolism of the nuclei developed. The chromatin content of karyoplasm decreased, the apparence of nuclei of irregular shapes became frequent.

Myelin figures and autophage vacuoles appeared in the cytoplasm indicating increasing of endocytotic processes.

In the extended cisterns of the rough endoplasmic reticulum paraprotein crystals accumulated.

The changes described above prove unambiguously that phenol induces serious degenerative lesions in the organs of vital importance of carps.

Mária Hegedűs, Enikő Dobler and E. Fekete

Comparative analysis of dead reaches of river Tisza on the basis of the 1988 investigations

In 1988 10 different places of 6 water territories of dead Tisza were investigated along the Csongrád-Szeged reach.

On basis of an integrated system of requirements as to the quality of surface-waters, the water quality of dead branches was as follows:

I st class in the dead-branch at the open-air bath of Mártély.

II st class of Atka and Körtvélyes dead-branches at the lockkeeper house and the tailbay.

II/IIIrd class at the lower end of Serházzug dead branch. Characteristically, IIIrd class at the Sports-ground, IIIrd class at Gyálarét at all the three places where the samples are generally taken. The water quality is the worst at Nagyfa characteristically III class.

On the basis of the most charasteristic result with the help of mathematical method we were looking for an answer to the question what kind of similarities or differences can be found in the conditions of the different water territories.

We could demonstrate that the quality of water in the dead branches differ and only one or two components showed seasonal changes in some sampling places.

K. BÁBA

Cenological and zoo-geographical evaluation of snails of convalaria oaken in Tőserdő

With the help of the square-method (50×25 cm) the author studied the yearly oscillation events in Tőserdő.

The data were evaluated with the help of the Czekanowski cluster analysis ecological species-groups obtained from the Feoli-Orloci block cluster and zoo-geographycal methods (BÁBA 1982). The results were compared to the author's regional data of convalaria oaken. It can be established that the snail fauna in the investigated wood is appropriate for the regional conditions in respect to zoogeographycal composition and from the point of view of structure as well.

The cenological character species of the oaken belong to type D, that is they represent open field snails. From the point of view of zoo-geography they are continental ubiquistic Holarctical and Turkestan fauna elements, typical for steppes.

The changes in aspect from sping to autumn are manifested in the decrease in characteristic due to a decrease in underground water.

GY. MOLNÁR

Data on the organization of heronries with special regard to the heron colony of the Tiszaalpár Nagylake

The heronry of Tiszaalpár Nagylake has been observed since 1979. Some of heron species have moved to Solymos marsh in the last two years. I have studied the temporal sequence of colony-making of eight heronspecies. A group of early arriving night herons gets organized around the group of spoonbills that arrive first. Birds hatching later occupy well-defined territories in groups which may indicate their simultaneous returning from the winter colonies. The sensitive heron species with striking feathering like little egrets, tufted herons occupy the middle region of the colony in spite of the later arriving. Joing the colony can be established from maping and thus an affinity order can be established among the species as well.

On the basis of estimations of distances of the nests from one other, the r values were calculated.

The heronry of Nagylake can be compared with the structure of flood plain colonies and further conclusion can be drawn.

A. LEGÁNY

A method for assesment of different territories from the nature-conservation point of view

Due to the changes brought by civilization areas where natural processes can be observed and studied gradually decrease. Thus it is necessary to turn these territories into nature conservation areas. Therefore, it is indispensable to have a quick assessing method that takes into account realities and can be applied in practice for different regions.

The need for completeness requires the development of zoological evaluating system similar to the botanical evaluating system that has been worked out previously.

Different animal groups are suitable for the above mentioned aim. In this report an evaluation method is suggested that holds for birds.

It can be seen that most suitable method in this respect is based on the summing up the point numbers assigned according to the nature conservation value categories of species.

On the basis different areas can be compared and categorized.

GY. CSIZMAZIA

Role of mammals in the reneval of planted and natural oak woods in inundation areas

The living conditions of 33 000 propagulums have been studied for four years in the inundation areas of river Tisza (Tiszadob-Felfág) in oak woods and replanted-woods.

Oak acorn and maple fruits were placed into 100 permanenet squares. The feeding and preference relations were studied with the help of 10 feeders. The parallel taps were set for catching alive and living habitat was explored.

The highest demage has been found in the case of oak acorn. 5 month after the exposure from about 2000 oak acorns only 12,5% of the seedlings survived.

During the same period in maple, seeds a 46% seedling development was observed. Preference studies have confirmed that oak acorns are eaten up mostly by wood mice and yellow necked wood mice. It has been also proved that the size of rodent population follows, although with a phase delay the quantity of acorn fruits. Knowing the primer production of the area studied and the number of individuals in the rodent population in it the level of consumption and the caused damages can be estimated.

In the areas studied the potential consumption can estimatedly reach 200—250 kg $ha^{-1}year^{-1}$, representing 58% of the yield. From the experimental data we can conclude that the renewal of natural oak woods is hardly possible because of the presence of rodent mammalians.

In the course of planting the gradational effects of mammals on the production of acorns have to be taken into account.

3. Reports on research in the Yugoslav region of the river Tisza

S. GAJIN, M. GANTAR, M. MATAVULJ and Z. OBREHT

Oligotroph bacterium flora in the dead Tisza

In the course of microbiological analysis of the water quality a close attention was paid to the dominant oligotroph microflora. The analysis of morphologically separated bacterium colonies on culture-medium applied for this purpose was carried out on the basis of the nutrient content of the culture medium. Besides the determination of growing ability and intensity the morphological changes of groups grown on less rich culture medium were followed electronmicroscopically.

V. PUJIN

Population dynamics of dominant Rotatoria species in the dead Tisza

The composition of zooplanktons and periphytons in the dead Tisza in Gyöngysziget on Yugoslav territory as well as in other waters of Pannon basin are characterized by the dominant and the most variable group of Rotatoria species. The numerical composition of species is characterized by an annual and seasonal dynamics It culminate to maximum in summer months. This lecture discusses the population dynamics of dominant species in the period of 1983—1988.

The frequency index (pF) is an indicator of the role of individual species.

$$pF = \frac{m}{n} \times 100$$

(n = the total number of samples
m = species number in sample takings)

Frequency of dominancy (DF)

$$DF = \frac{md}{n} \times 100$$

md is the number of dominant species in sample takings.

The NAIDENOV, WAWRIK method (1984) was applied to calculate dominance frequency.

$$DT = \frac{DF}{pF} \times 100$$

Most frequently occuring dominant species belong to the *Brachionus, Keratella* and the *Polyarthra* genus.

R. RATAJAC

The composition of Crustancea and population dynamics of its dominant species in dead Tisza

The author studied two groups of Crustacea (Cladocera and Cocepoda). Annual and seasonal changes could be established. High value density of dominant species was registered in summer period.

The presence of some ecosystem studied.

N. DJUKIĆ and S. MALETIN

The dynamics of the Oligochaeta association in the dead Tisza

The study of oligochaets is an integral part of the complex hydrobiological investigations of the dead Tisza at Gyöngysziget. It was established that a structural change occured in the association in the period between 1983—1985.

Taking into consideration the quantitative analysis the relative abundance of dominant *Limnodrilus hoffmeisteri* increased year by year.

Within the abundancy increase of Oligochaets the growing contribution of *L. hoffmeisteri* is in close correlation with the accelerated eutrophisation process charasteristic for the dead branch as a result of organic loading.

S. MALETIN and D. KOSTIĆ

Growth rate of fish in the dead Tisza in function of types of feeding

The authors studied the growth rate of 8 fish species belonging to different feeding types caught from the dead Tisza in 1987. These are:

— Planktophage: *Scardinius erythrophthalmus*
— Plankhobenthophage: *Rutilus rutilus, Abramis brama*
— Benthophage: *Carassius carassius, Carassius auratus gibelio*
— Carnivores: *Esox lucius, Perca fluviatilus* and *Stizostedion luciopeca*

It has been established that the differences in the growth rate of the fish species studied among other factors within the ecology valency are in function of feeding types, too.

S. MALETIN, N. DJUKIĆ and D. KOSTIĆ

Growth and productivity of Lepomis gibbosus (Pisces, Centrarichidae)

In the course of 1985 the authors investigated 273 L. gibbosus individuals taken from the dead Tisza from the point of view of growth and productivity. The average length of 3—7 year old specimens measures 102—146 mm and their mass 48—11 gs.

The average values of the absolute productivity depending on the age vary between 4474—11 668 roe-corns, whether those of the relative productivity are in the range of 11—127 roe-corns.

Comparing specimens of naturalized alochton species introduced in waters of Europe more than 100 years ago with specimens originating from their native environment it has been established that in the case of *L. gibbosus* specimens living in the Tisza their longitudinal growth is identical.

L. BUDAKOV

Nutrition biology of pikes *Esox Lucius* L. (Esocidae, Pisces)

The author studied the nutrition biology of pikes caught from Tisza in the period of 1980—1983.

The body length of one-year old specimens varies in the range 263—702 mm. The length of alimentary canal is 113.79 mm. The mass index is 6.41 g. The analysis of the stomach content was carried out depending on the age and the seasonal nutrition cycle.

Besides considerable amount of detritus fish belonging to 12 different species have been also found in the stomach.

The most frequent pray are: *Rutilus* L. and *Carassius auratus gibelio* BLOCH.

M. MIKES and V. HABIJAM

Small-mammal cenoses along the Gyöngysziget dead Tisza

The distribution of small mammals according to areas, quality and quantity was studied by means of analysis of owl casts.

Cast samples were taken from two habitats:

Along the Földvár reach of Gyöngysziget dead Tisza at the group wintering locality of long-eared owls *(Asio otus)* as well as at the permanent quarters of barn owls *(Tyto alba)* situated at a distance of about 800 m in a farm building. From the 200 casts the remains of 544 vertebrate individuals and of 3 insect species were found (*A. otus* — 126 casts) 290 ind., T. alba — 94 (254).

It has been established that both owl species prefer first of all small mammals belonging to the order of insectivores and rodents. At both habitats Sorex araneus and *Crocidura leucodon amounts* to 2/3 of the insectivorous victims, whether *Microtus arvalis, Apodemus sylvaticus constitute* 75% of the rodents.

The qualitive differences in the feeding of owls can be attributed to the biocenological charasteristics of the habitat. That is while the hygrophylous species *(Apodemus agrarius, Arvicola terrestris,* and *Ondatra zibethica)* are part of the rush-bulrush red association in the dead Tisza, *M. arvalis, Mus musculus* spiceligeus and *A. sylvaticus,* that have been also found in owl-casts are naturally representatives of the dominant small mammal cenosis from the surrounding pkough-lands.

M. TOTH

Interaction of the waters of river Tisza and river Bega

Between May and October of the current year values of basic physical and chemical factors as well as the zooplankton composition were measured in two-weeks periods at Titel in Tisza and Bega at the third and the eighteenth kms from the mouth.

The purpose of this work was to determine the similarity coefficient of the two rivers.

P. Bózsa

Taxonomical and ecological relation of *Glycyrrhiza echinata* L. group in the lower Tisza reach

From the results of our investigations follows that also in the lower reach of Tisza *Glycyrrhiza echinata* L. can be devided into two clearly distinguishable species such as *G. echinata* L. and *G. subechinata* sp. nova.

It can be proven on the basis of significant morphological, morphoanatomical, physiological and biochemical differences.

The separation is obvious from the point of view of ecology as well. *G. echinata* can be found in dry areas outside the inundation areas of Tisza where the phreatical level of the water-table lies deeply under the surface.

G. subechinata occurs in the inundation area, too, and generally in places where the phreatical water is closer to the surfice. Both species are heliophylous but *G. subechinata* survives longer in halfshaded places.

From the point of view of phytocenology *G. echinata* is rather a member of weed association while *G. subechinata* can be found in borderlands of inundation wood areas and grass fields.

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